Upper Long Lake Watershed

Noble County, Indiana

DIAGNOSTIC STUDY

April, 1998

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Submitted to:

UPPER LONG LAKE ASSOCIATION
NOBLE COUNTY, INDIANA

Submitted by:

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FOREWORD

AUSPICES

The Upper Long Lake Diagnostic Study was authorized by the Upper Long Lake Association. Funding for the study was provided by Upper Long Lake Association under a grant from the Indiana Department of Natural Resources (IDNR), Division of Soil Conservation "T-by-2000" Lake and River Enhancement Program.

ACKNOWLEDGEMENTS

The long enduring patience of the "T by 2000" Lake and River Enhancement Program staff and the Upper Long Lake Association is greatly appreciated.

Randy Jones of the DeKalb County Soil and Water Conservation District inspected proposed wetland restoration sites and commented on the feasibility of U.S. Fish and Wildlife funding.

Analysis for stream samples were performed by Edglo Laboratories, Inc. of Fort Wayne. Denver Howard provided instructions for sound sampling techniques.

Thanks to Barry Bortner of the Noble County Soil and Water Conservation District for input regarding conservation efforts within the watershed.

The United States Department of Agriculture, Noble County Farm Service Agency Office assisted in providing information regarding Conservation Reserve Program acreage within the watershed.

Thank you to the late Bryan Leitch, past Upper Long Lake Association President and friend. Thank you for your conservation efforts and interest in the watershed and the lake. Thank you for helping me plant trees on my land and for all the times you plowed snow from our driveways. May the trees on your land grow tall, and may you forever fish clean lakes.

EXECUTIVE SUMMARY

INTRODUCTION

Gensic & Associates and Environmental Testing of LaPorte County, Inc. provided professional services to the Upper Long Lake Association in conducting a diagnostic study of the restoration of the Upper Long Lake Watershed. The study was funded by the Upper Long Lake Association with the aid of a grant from the Indiana Department of Natural Resources, Division of Soil Conservation "T-by-2000" Lake and River Enhancement Program.

Members of the Upper Long Lake Association have became increasingly concerned with the perceived deterioration of lake water quality. Principal areas of concern include aquatic plant concentrations and algal blooms, quality of runoff water in inflowing ditches and tiles, sediment deposition at inlets, and a declining fishery. The growing environmental awareness of local residents, and the desire to reverse the causes of cultural eutrophication of the lake were primary factors for the authorization of the study.

The principal objectives of the study were fourfold:

1. Map the Upper Long Lake Watershed and its principal drainage courses and subwatersheds.

2. Map land use and highly erodible soils in the watershed and identify areas of concern which may pose a threat to the health of Upper Long Lake.

3. Assess the historical and current conditions of the lake and establish baseline data for the continued assessment of lake water quality.

4. Provide information and develop recommendations to assist the Upper Long Lake Association in the management of its watershed and lake.

WATERSHED

Problems in the Upper Long Lake Watershed result from both natural topographic characteristics and current land use. The watershed contains 779 acres (315 hectares) of Highly Erodible Land (HEL) amounting to approximately 58 percent of the watershed land area. Agricultural land comprises over 68 percent of the watershed area and more than 268 acres (110 hectares) of HEL are currently used as cropland. Nearly 10 percent of the watershed is developed, principally in the lake shoreline areas. These shoreline areas comprise over 15 percent of the watershed land area and are at least 28 percent Highly Erodible Land.

Water quality was sampled from selected inflowing drainage courses after a storm event. Results of laboratory analysis indicate high values for suspended solids particularly in the subwatersheds where land use is dominated by agriculture.

The principal source of sediment and nutrient contamination of runoff water in the Upper Long Lake Watershed is erosion on individual fields due to agricultural cropping practices on Highly Erodible Lands.

The Upper Long Lake Watershed contains nine separate subwatershed and drainage areas. The largest subwatershed contains only 25 percent of the entire watershed system. Recommendations are presented to address problems throughout the Upper Long Lake Watershed. No single subwatershed should be targeted as the major source of water quality problems without recognizing the cumulative effects of the other subwatersheds and areas.

Watershed recommendations include:

1. Institutional actions by the Upper Long Lake Property Owners Association to better enable the organization to deal with environmental and lake and watershed management issues.

2. Implementation of best management practices in both the agricultural areas and developed lake shoreline areas of the watershed.

3. Restoration or construction of wetland areas or construction of detention ponds in the watershed to reduce peak runoff flows and alleviate sedimentation.

LAKE

Our study of the water quality of Upper Long Lake has determined that the overall water quality remains good and has changed little in the last two decades. The sediments do not seem to have excess levels of nutrients and the total phosphate level is especially low. Problems with low growth among bluegills remain and IDNR will probably not expend further resources to determine the cause and solution to this problem because of its intractability. The aquatic macrophyte assemblage is diverse and is not dominated by .weedy. species and is typical of alkaline lakes of the region. Overall, management of potential lake problems associated with loading will be best addressed by ensuring that inputs from the watershed are controlled to prevent entry of excess nutrients and other substances into the lake water.

INTRODUCTION

DESCRIPTION OF UPPER LONG LAKE WATERSHED

The Upper Long Lake Watershed is located in southwest Noble County, Indiana. Upper Long Lake and its watershed are drained to the north by the Kirkpatrick Ditch. Kirkpatrick Ditch is tributary to the South Branch of the Elkhart River, Elkhart River, Saint Joseph River, and Lake Michigan.

The area of the greater watershed above the outlet control structure below Upper Long Lake is approximately 1336 acres (541 hectares). This area includes 20 acre (8 hectares) Pleasant Lake and its 175 acre (71 hectares) watershed. The area of Upper Long Lake is 85 acres (34 hectares), and its immediate watershed contains 1056 acres (427 hectares).

The elevation of Pleasant Lake is 909 ft. (277.1 m) M.S. L. Pleasant Lake and its watershed are drained by approximately 5000 ft. (1520 m) of tile and 6300 ft. (1920 m) of open ditch. This drainage flows to the east side of Upper Long Lake. The elevation of Upper Long Lake is 891 ft. (271.6 m) M.S.L.

Soil types in the greater Upper Long Lake Watershed are primarily Morley Blount with Houghton Muck in drained historic wetland areas. Fifty-eight percent of the land area of the watershed is classified as highly erodible soils.

The watershed is rural and land use is largely agricultural, however the past decade has witnessed a decline in farming and an increase in residential housing in this area.

PURPOSE

Members of the Upper Long Lake Association have become increasingly concerned with the perceived deterioration of lake water quality. Principal areas of concern include aquatic plant concentrations and algal blooms, quality of runoff water in inflowing ditches and tiles, sediment deposition at inlets, and a declining fishery. The growing environmental awareness of local residents and the desire to reverse the causes of cultural eutrophication of the lake were primary factors for the authorization of the study.

The principal objectives of the study were fourfold:

1. Map the Upper Long Lake Watershed and its principal drainage courses and subwatersheds.

2. Map land use and highly erodible soils in the watershed and identify areas of concern which may pose a threat to the health of Upper Long Lake.

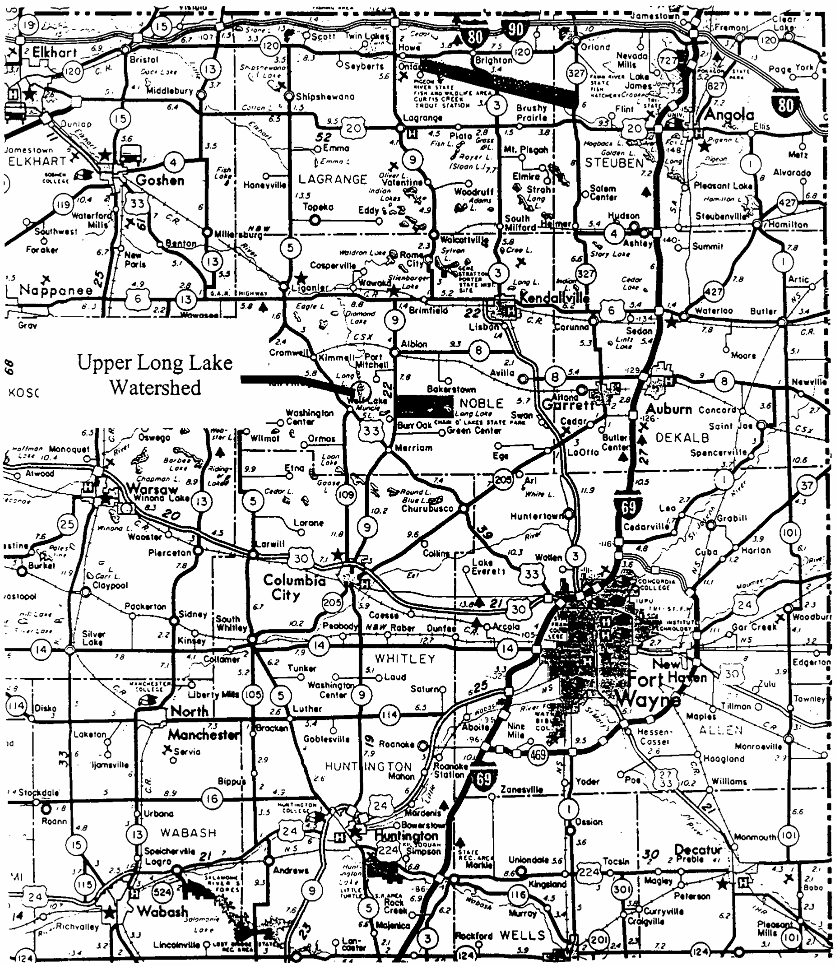


Figure 1. Upper Long Lake Watershed Location Map

3. Assess the historical and current conditions of the lake and establish baseline data for the continued assessment of lake water quality.

4. Provide information and develop recommendations to assist the Upper Long Lake Association in the management of its watershed and lake.

WATERSHED SURVEY

WATERSHED SURVEY

INTRODUCTION AND METHODS

STUDY AREAS

The Greater Upper Long Lake Watershed was divided into eight subwatersheds and one shoreline area. Each subwatershed and the shoreline area are presented separately in this report. The area referred to as the Greater Upper Long Lake Watershed includes Pleasant Lake and its watershed. This report will refer to the Pleasant Lake Watershed as a subwatershed of Upper Long Lake. It appears that drainage out of the Pleasant Lake Watershed has little or no adverse impact on Upper Long Lake.

Each subwatershed consists of land area drained to Upper Long Lake by a surface watercourse or a drainage tile. The shoreline area contains land adjacent to the lake where surface water runoff flows directly into the lake without significant channelization.

The greater watershed was divided into subwatersheds and the shoreline area to isolate problem areas and runoff water quality. The subwatersheds and shoreline area were examined separately and are presented separately in this report.

LAND USE

For this study land use is divided into the following five general categories: grassland, cropland, wetland, woodland, and residential.

Grassland is classified for this report as land covered predominately by grassy vegetation including hay, pasture, and fallow fields. Most of the areas classified as grassland were once cultivated fields. Land in the Conservation Reserve Program (CRP) is classified as grassland.

Cropland is defined as tilled land where row crops or small grains are cultivated. Tillage methods were not addressed in this report.

Seasonal and permanent wetlands and constructed ponds are classified as wetland. The greater watershed contains numerous small seasonal upland wetlands and depressions which were not measured for this report. These depressions are important to runoff water quality, but they were difficult to locate and measure for this study.

Woodlands are found as individual woodlots on slopes or on land not historically suitable for agricultural use.

Land use is classified as residential if its primary use is for a permanent residence, seasonal cottage, business establishment, or farmstead. Vacant lots surrounded by developed area fall into the residential classification. Although there are several farms in the greater watershed, there are no major livestock operations to warrant a separate category for feedlots or farmsteads. Developed areas are concentrated primarily in the shoreline area with scattered housing and farmsteads in the upland subwatersheds.

SOILS

Upland soils in the Upper Long Lake Watershed are primarily of the Morley-Blount association formed in glacial till. Land formations are gently sloping to moderately steep. The watershed upland also contains minor areas of Chelsea, Rawson, Metea, Miami, and Riddles soils. Depressional areas and outwash plains contain Edwards, Houghton, Pewamo, Palms, Milford, Wallkill, and Washtenaw soils. Land slopes range from 0 to 25 percent.

The upland soils associations are well suited to trees or hay and pasture. Erosion is a hazard to Morley soils used as cropland.

HIGHLY ERODIBLE LAND

The total area of highly erodible land (HEL) in each subwatershed is noted, and the agricultural portion of the HEL is classified as active cropland or conservation reserve. Fallow cropland or grassland is not noted in the Land Use Summary.

The following soils in the Upper Long Lake Watershed are classified as highly erodible:

Chelsea fine sand, 6 to 12 percent slopes
Miami loam, 2 to 6 percent slopes, eroded
Morley silt loam, 2 to 6 percent slopes, eroded
Morley silt loam, 6 to 12 percent slopes, eroded
Morley silty clay loam, 6 to 12 percent slopes, severely eroded
Morley silty clay loam, 12 to 18 percent slopes, severely eroded
Morley soils, 18 to 25 percent slopes
Rawson loam, 2 to 6 percent slopes
Riddles sandy loam, 6 to 12 percent slopes, eroded

FIELD CATEGORIES

Subwatersheds were divided into individual fields. Fields were assigned a category based on the following criteria:

Category 1 Field

A Category 1 Field contains highly erodible land (HEL) and is currently used as cropland. Runoff from a Category 1 field flows directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 2 Field - A Category 2 Field is a field currently used as cropland which contains little or no HEL. A Category 2 Field discharges runoff directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 3 Field - A Category 3 Field contains HEL and is currently in CRP, grass, or hay cover. A Category 3 Field discharges runoff directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 4 Field - A Category 4 Field contains HEL currently used as cropland. A Category 4 Field discharges runoff into a wetland or depression where runoff is detained prior to entering a lake.

Category 5 Field - A Category 5 Field contains HEL currently in CRP, grass, or hay cover. A Category 5 Field discharges runoff into a wetland or depression where runoff is detained prior to entering a lake.

TOTAL GREATER UPPER LONG LAKE WATERSHED

The following is a summary of land use in the Greater Upper Long Lake Watershed:

	Acres	Hectares	Percentage of Greater Watershed
Total Greater Watershed Land Area	1336	541	
Grassland Area	505	205	38
Cropland Area	403	163	30
Wetland Area	56	22	4
Woodland Area	139	59	11
Residential Area	124	50	9
Upper Long Lake Area	85	34	6
Pleasant Lake Area	20	8	2
Total Highly Erodible Land (HEL)	779	315	58
Active Cropland in HEL	268	110	20
Conservation Reserve Program in HEL Area	258	106	19

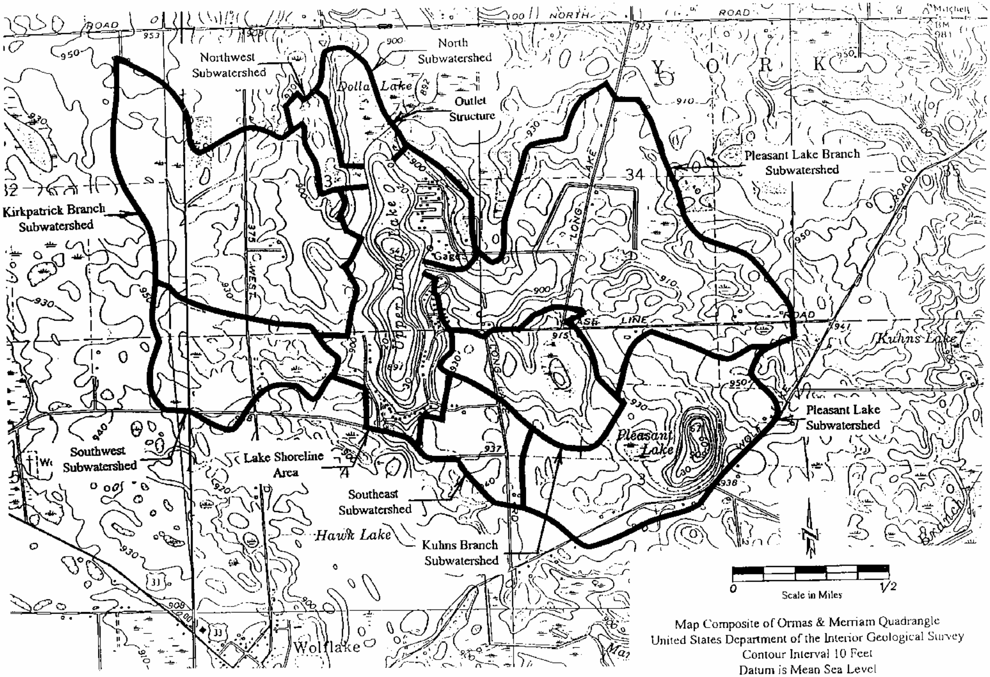


Figure W1. Upper Long Lake Greater Watershed Indicating Subwatersheds

STREAM SAMPLES

In order to preserve continuity, laboratory results from stream samples are presented as a part of each subwatershed discussion. Actual laboratory test results are included in Appendix A of this report. Water samples from open ditches and field tile discharges are referred to in this report as stream samples.

The Pleasant Lake Branch Ditch flowing into the channel on the east side of the lake is the only perennial stream in the greater watershed. The Pleasant Lake Branch is the outlet from Pleasant Lake. The Kirkpatrick Branch which discharges into the west side of the lake is intermittent. The remainder of the subwatersheds and the shoreline area are drained by field tile or shallow overland flow.

Base stream flows were sampled from the Pleasant Lake Branch and from the Kirkpatrick Branch Ditch, although the Kirkpatrick Branch is intermittent it does carry discharge from field tile for an extended period of time after sufficient rainfall. Storm runoff flows were sampled from the two open ditches and from four field tiles on June 7, 1993. Samples were taken after a thunderstorm when cropland had been planted prior to significant emergence of crops.

It must be noted that it is difficult to quantify how flows in ditches and tile will react to storm events in this watershed. Quantity of runoff is dependent on antecedent moisture, rainfall duration and intensity, condition of vegetation, and condition and use of cropland.

Stream samples were collected in acid washed bottles and kept on ice until delivery to Edglo Laboratories in Fort Wayne for analysis.

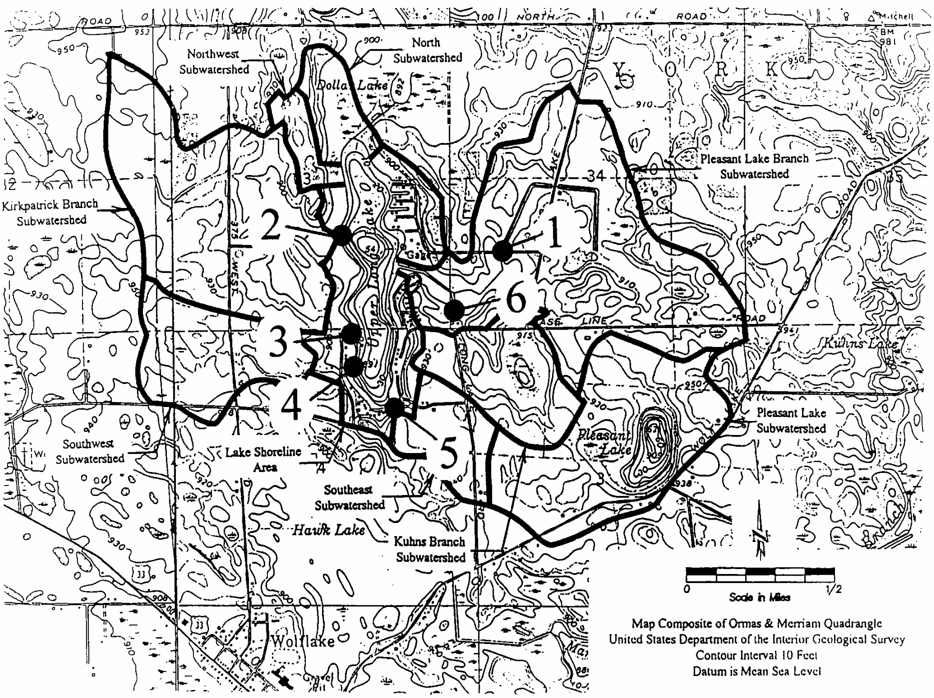
The samples were analyzed for:

1. Total Suspended Solids. The total organic and non organic particulate matter within the water. Total solids include sediment which may transport attached nutrients.

2. Total Phosphorus. Phosphorus which is immediately available for use by plants and phosphorus compounds which may decompose and become available for plant use

3 Total Kjeldahl Nitrogen. Free ammonia and organic nitrogen available for plant use.

Stream samples were not tested from the Northwest, North, and Pleasant Lake Subwatersheds. Pleasant Lake Subwatershed discharges directly from Pleasant Lake. Pleasant Lake water quality was not a subject of this report. The North Subwatershed discharges to a wetland below Upper Long Lake yet upstream from the lake control structure. The tile which drains the Northwest Subwatershed is buried in a wetland and is not visible.



1. **Pleasant Lake Branch Subwatershed (Ditch)**
2. **Kirkpatrick Branch Subwatershed (Ditch)**
3. **Lake Shoreline Area (Cohee Tile)**
4. **Southwest Subwatershed (Sunset Tile)**
5. **Southeast Subwatershed (Kohn Tile)**
6. **Kuhn Branch Subwatershed (Tile)**

Figure W2. Upper Long Lake Stream Sample Locations

BASE FLOWS			
Sample	**Sus. Sol.**	**Phos.**	**TKN**
	MG/L	**MG/L**	**MG/L**
1. Pleasant Lake Branch - Open ditch	<5.0	<0.10	3.0
2. Kirkpatrick Branch - Open Ditch	<5.0	<0.10	9.0
STORM RUNOFF FLOWS (PEAK FLOWS)			
Sample	**Sus. Sol.**	**Phos.**	**TKN**
	MG/L	**MG/L**	**MG/L**
1. Pleasant Lake Branch - Open Ditch	635.0	0.17	5.0
2. Kirkpatrick Branch - Open Ditch	1088.0	0.61	8.0
3. Lake Shoreline - Cohee Tile	73.0	0.31	4.0
4. Southwest Subwatershed - Sunset Tile	755.0	0.20	9.0
5. Southeast Subwatershed - Kohn Tile	2710.0	0.81	11.0
6. Kuhn Branch - Tile	106.0	0.27	1.0

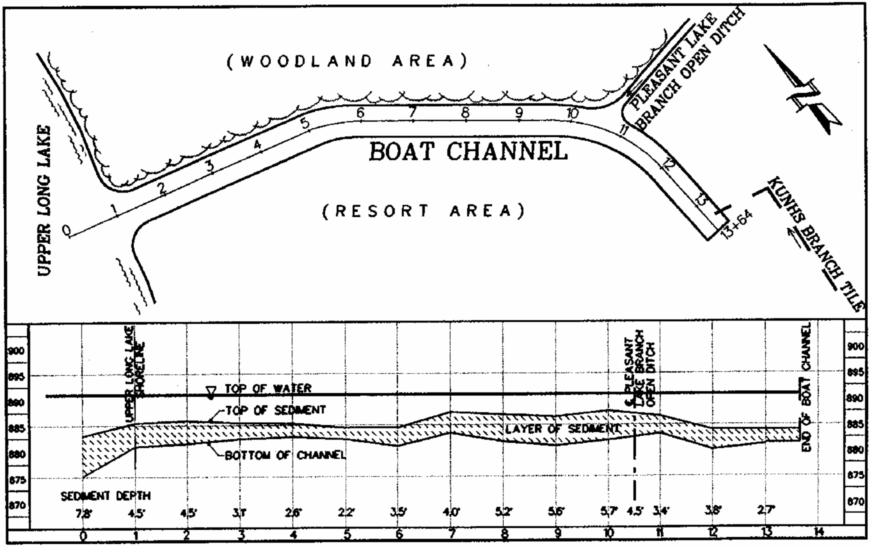
Sample = Subwatershed (See figure W2.)
Sus. Sol. = Total Suspended Solids
Phos. = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
MG/L = Milligrams per Liter

Table W1. Stream Sample Laboratory Results

LAKE SEDIMENTATION

Sediment depths were measured to determine if the Pleasant Lake Branch Ditch deposited significant sediment in the lake at the mouth of the ditch (boat channel) outlet. Sediment depths were measured in the winter by probing through holes bored in the ice. Hollow plastic pipe with a sharpened edge was used to measure the distance from the ice cover to the top of the sediment layer. The pipe was forced through the sediment layer and a second measurement was made at refusal. This method assumes that refusal was reached at the original lake bottom, in this case at consolidated marl.

A typical profile of sediment depth was measured at the outlet of the Pleasant Lake Branch Ditch (boat channel). Two additional sediment depth profiles were measured at separate locations perpendicular to the edge of the lake in areas not affected by inflowing ditches or tiles. Although original note data



SCALE: 1" = 200'

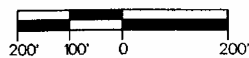


Figure W3. Plan & Profile of Boat Channel and Sediment Layer

for these profiles were lost the author noted that the sediment depth profile at the mouth of the boat channel did not vary significantly from normal lake edge sediment profiles.

The boat channel was dredged in approximately 1955. The channel discharges into the lake approximately 200 feet south of the original open ditch outlet. The ditch was relocated at that time to discharge into the channel approximately 900 feet upstream from the lake. The boat channel is approximately 1300 feet long and varies in width from 55 to 68 feet. The channel was originally excavated approximately 10 feet deep. The channel now contains from 3 to 6 feet of sediment. It is assumed that the boat channel acts as a sediment basin protecting Upper Long Lake from heavier sediments transported by the Pleasant Lake Branch Ditch during peak runoff flows.

The author owns approximately 1600 feet of the Pleasant Lake Branch Ditch upstream from County Road 25 N. The ditch was last dredged in approximately 1975. Two to three feet of sediment have accumulated in the ditch bottom since the last dredging. Wetland vegetation is naturally established in the ditch bottom and this vegetation appears to filter sediments during low flows.

RECOMMENDATIONS

Recommendations are made considering continued use of private property by owners, economics, and the existing social and political capabilities for implementing the recommendations. Improvements to the watershed and ultimately the water quality of the lake will require dedication and perseverance from those committed to conservation and the long term health of the lake.

Recommendations regarding unique conditions specific to a subwatershed are presented in the subwatershed section of this report. General recommendations regarding agricultural use are presented in the recommendations section of the report. A separate section of the report is also presented for the restoration of wetlands or the construction of runoff detention areas. Agencies and assistance programs are also listed in the recommendations section following the subwatershed sections of the report.

MAPS

Maps were prepared as an aid to visualizing the watershed and its features. Maps may be referred to as the report is read. Maps used as figures in this report were prepared from United States Geological Survey Quadrangle Maps. Highly erodible soils areas were determined from the United States Department of Agriculture Soil Conservation Service Soil Survey of Noble County, Indiana. A composite aerial mylar map of the greater watershed was prepared by Williams Aerial & Mapping, Inc. of South Bend, Indiana. The composite was made from 1986 photography. The aerial map is at a scale of 1 inch equals 400 feet and is included in a packet in the back of the report.

Watershed and subwatershed boundaries were established by field inspection of the study area with aerial photography and a topographic map in hand. Current land use was verified in the field. Each watercourse was inspected and channel conditions were noted. Drainage courses were frequently checked during rainfall events to observe the drainage patterns of the watershed and the visible characteristics of runoff water.

The greater watershed, subwatersheds, land use, and highly erodible land areas were measured by planimeter from aerial photography. Due to the scale of the mapping, areas are not necessarily precise, and area measurements are rounded.

SIGNIFICANT NATURAL AREAS

According to the Indiana Natural Heritage Data Center there are no documented endangered, threatened, or rare species or high quality natural communities and natural areas in the Upper Long Lake Watershed. See Appendix B.

HISTORIC NOTES

As a note of interest an historic map of the Upper Long Lake area is included in this section of the report. The map indicates large areas of wetland adjacent to the lake and in the natural drainage courses flowing into the lake. Through time these natural wetlands were channelized and tiled to aid drainage for agriculture. These historic wetlands now appear as Houghton soils in low lying areas.

Upper Long Lake, Dollar Lake, Lower Long Lake, and adjacent wetlands were probably one body of water prior to the dredging of the ditch north of Lower Long Lake. The ditch lowered the surface water elevation for the entire Long Lakes system.

Land for the cottages and homes along the east side of Upper Long Lake was created by dredging boat channels and depositing dredged material in the lakeside wetlands.

Marl was once dredged from the northwest corner of the Lake for use as agricultural lime. Areas of the lake and adjacent Houghton soils are underlain with marl. This marl creates what is known as alkaline or sweet muck.

The author has found stone tools on uplands and arrow heads in muck areas in this watershed. Apparently Native Americans camped on high ground and hunted these historic wetlands.

Figure W4. Historic Map of Upper Long Lake Area

From an Illustrated Historical Atlas of Noble County, Indiana
Published by: Andreas & Baskin
Chicago, IL
1894

PLEASANT LAKE SUBWATERSHED

DESCRIPTION

Pleasant Lake Subwatershed lies south of Baseline Road, east of County Road 300 West, and north of Wolf Lake Road. This is the third largest subwatershed in the Greater Upper Long Lake Watershed. This subwatershed is 72 percent highly erodible land (HEL) and land use is primarily agricultural. There are several houses along the east shore of Pleasant Lake.

The area west of Pleasant Lake is drained by Pleasant Lake Branch Tile which discharges into the west side of the lake. In general the areas south and east of the lake drain directly into the lake and the area north of the lake drains to the wetland on the north side of the lake. The Pleasant Lake Branch Tile flows north from Pleasant Lake through the Pleasant Lake Branch Subwatershed. The tile discharges into an open ditch, which discharges into the boat channel on the east side of Upper Long Lake.

Pleasant Lake and the wetland north of the lake act as effective sediment basins for flows entering the Pleasant Lake Branch Tile. Lake water quality was not examined as a part of this report.

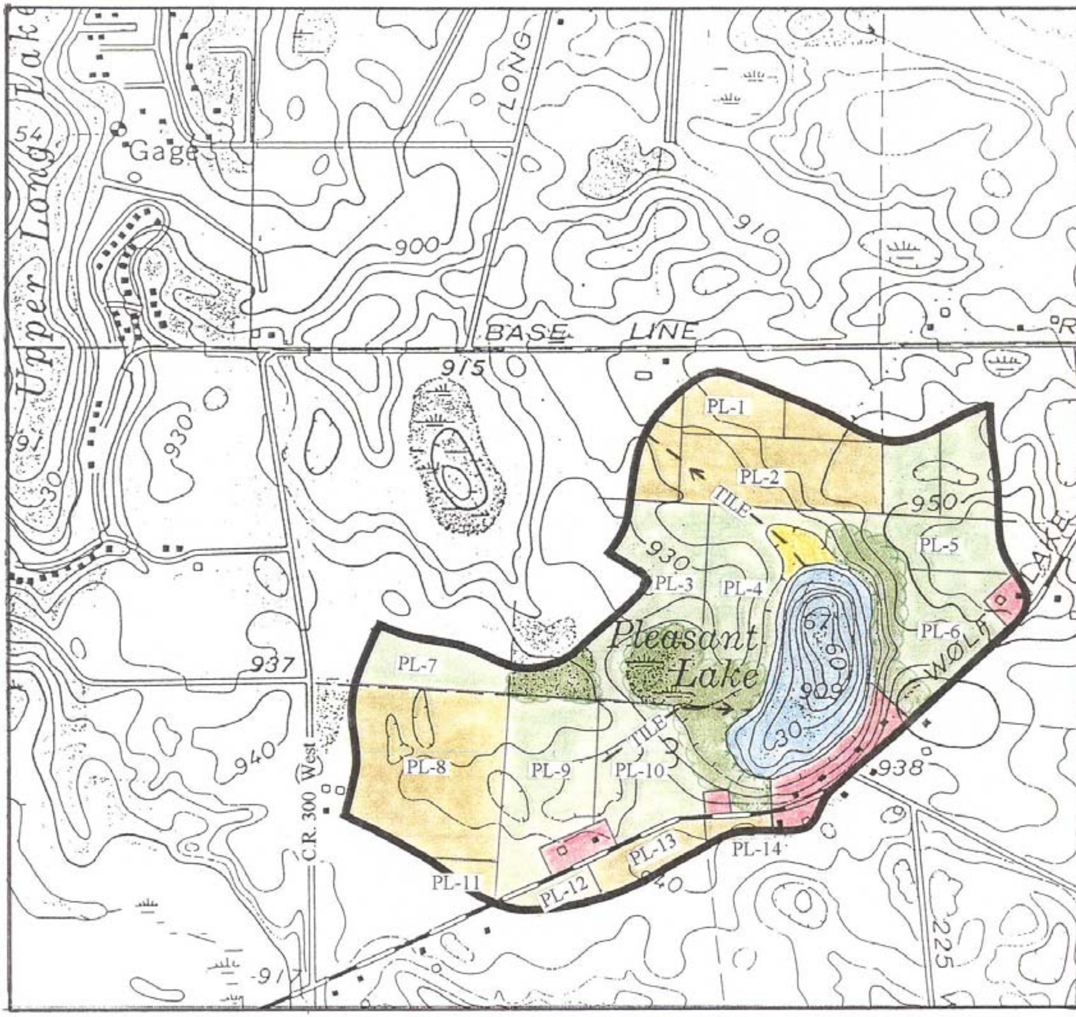
LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	195	79	
Grassland Area	77	31	40
Cropland Area	60	24	31
Wetland Area	4	2	2
Woodland Area	24	10	12
Residential Area	10	4	5
Pleasant Lake Area	20	8	10
Highly Erodible Land (HEL) Area	140	57	72
Cropland in (HEL) Area	51	21	26
Conservation Reserve Program (CRP) Area	47	19	24

FIELD CATEGORIES

Refer to page 6 for Category descriptions.

Category 1 Fields
Fields PL-1 and PL-2 are Category 1 fields because the Pleasant Lake Branch Tile runs through them. It is not known if surface runoff flows directly into the tile through inlets or blow holes.



Upper Long Lake
Pleasant Lake Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

500' 0 500' 1000'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Surv
Contour Interval 10 Feet
Datum is Mean Sea Level

Category 2 Fields
There are no Category 2 fields in this subwatershed.

Category 3 Fields
Fields PL-3, PL-4, and PL-10 drain to the Pleasant Lake Branch Tile. Fields PL-5, PL-6, and part of PL-4 drain directly into Pleasant Lake. Fields PL-3, PL-4, PL-5 and PL-6 are currently under CRP contracts which expire in 1997.

Category 4 Fields
Fields PL-8, PL-11, PL-13, and PL-14 are Category 4 fields. Fields PL-8 and PL-11 drain through a drained depression west of Pleasant Lake where runoff water enters the Pleasant Lake Branch Tile. Fields PL-13 and PL-14 drain to the Wolf Lake Road side ditch. The runoff water then flows under the road and into Pleasant Lake.

Category 5 Fields
Fields PL-7, PL-9, and PL-12 are Category 5 fields. Runoff water from these fields flows into a drained depression west of Pleasant Lake where the runoff water enters the Pleasant Lake Branch Tile. Field PL-7 is currently under a CRP contract which expires in 1997.

STREAM SAMPLES

Stream samples were not collected from this subwatershed.

SPECIAL RECOMMENDATIONS

There are no special recommendations for this subwatershed. General agricultural land management recommendations are presented on page 57.

PLEASANT LAKE BRANCH SUBWATERSHED

DESCRIPTION

The Pleasant Lake Branch Subwatershed is located east of Upper Long Lake and primarily north of Baseline Road. This 344 acre (139 hectares) area is the largest subwatershed in the Greater Upper Long Lake Watershed. This subwatershed is primarily agricultural and is 65 percent highly erodible land (HEL). The area also contains several wetlands and numerous drained depressions. Cropland comprises only 21 percent of the subwatershed however two fields in HEL are adjacent to the open ditch.

The Pleasant Lake Branch Tile flows generally north from Pleasant Lake and discharges into the Pleasant Lake Branch Open Ditch east of Long Lake Road and County Road 25 North. The open ditch continues to flow north before it bends west and then south and discharges into the boat channel. The boat channel discharges into the east side of Upper Long Lake. Several tiles, natural swales, and roadside ditches which drain adjacent depressions and uplands discharge into the open ditch. The open ditch and boat channel banks are vegetated and there appears to be little problem with erosion in the ditch. The lower reaches of the ditch contain wetland vegetation in the channel. The vegetation has caused considerable sedimentation in the ditch. There are areas of the ditch in muck soils where the ditch appears as a long narrow wetland.

LAND USE SUMMARY

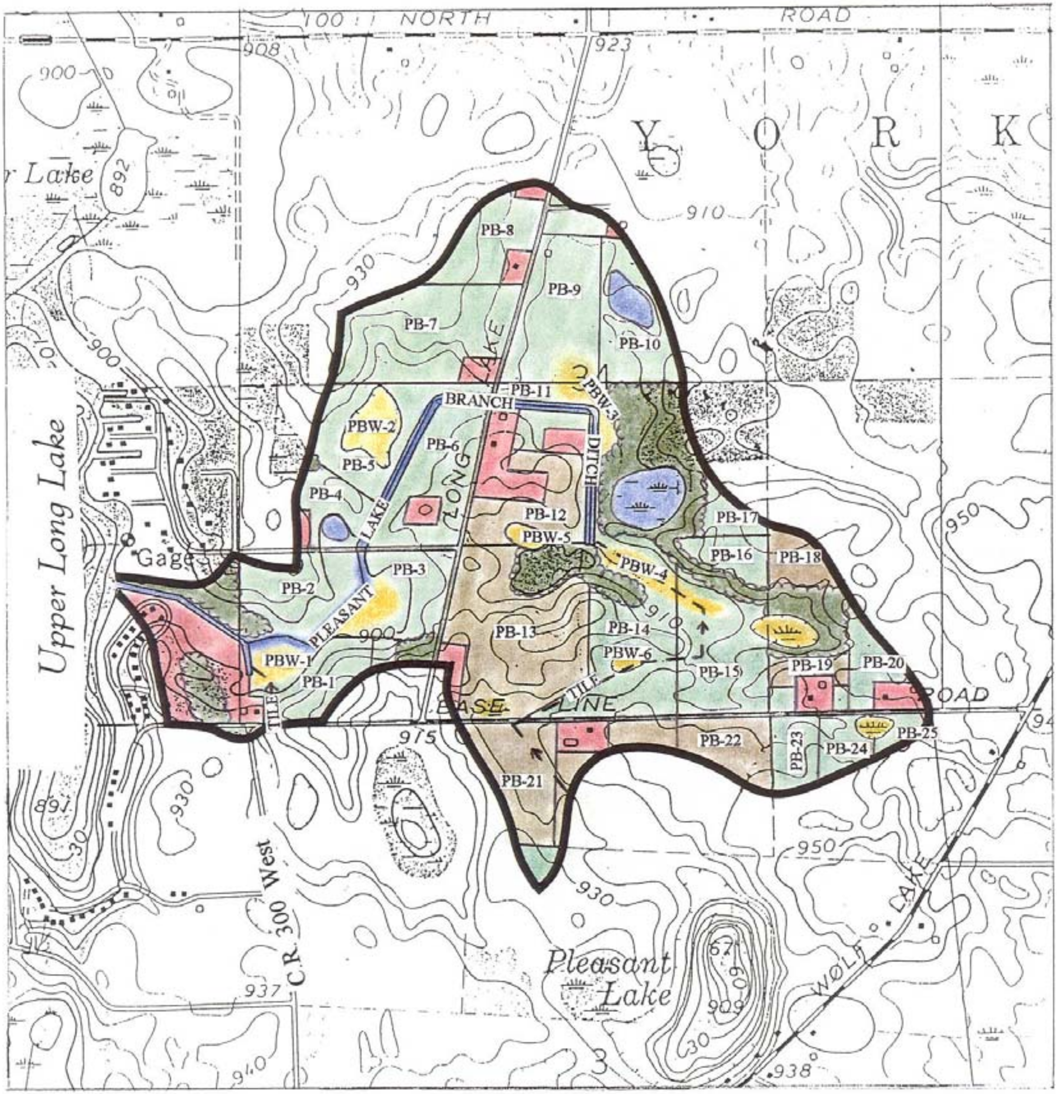
	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	344	139	
Grassland Area	175	71	51
Cropland Area	71	29	21
Wetland Area	20	8	6
Woodland Area	45	18	13
Residential Area	33	13	9
Highly Erodible Land (HEL) Area	224	90	65
Cropland in HEL Area	57	23	17
Conservation Reserve Program (CRP) Area	73	30	21

FIELD CATEGORIES

Refer to page 6 for Category descriptions.

Category 1 Fields

Fields PB-12, PB-13, and PB-21 are Category 1 fields. Runoff water from fields PB-12 and PB-13 flows directly into Pleasant Lake Branch Open Ditch. The Pleasant Lake Branch Tile runs through



Upper Long Lake
Pleasant Lake Branch Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

750' 0 750' 1500'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

field PB-21. However it is not known if runoff water enters the tile directly.

Category 2 Fields
There are no Category 2 fields in this subwatershed.

Category 3 Fields
Fields PB-1, PB-2, PB-3, PB-4, PB-5, PB-6, PB-11, PB-14, and PB-15 are Category 3 fields. Runoff water from fields PB-1, PB-2, PB-3, and PB-4, PB-5, PB-6, and PB-11 flows directly into the Pleasant Lake Branch Open Ditch. Runoff water from fields PB-14 and PB-15 is drained by the Pleasant Lake Branch Tile. Fields PB-1, PB-2, PB-3, and PB-4 are currently under CRP contracts which will expire in 1997.

Category 4 Fields
Fields PB-18, PB-19, and PB-22 are Category 4 fields. Runoff water from fields PB-18 and PB-19 flows into a drained depression north of field PB-19 which drains into the Pleasant Lake Branch Tile. Field PB-22 drains into the Baseline Road side ditch, where runoff water flows under the road and into a drained depression north of Field PB-19. The depression drains into the Pleasant Lake Branch Tile.

Category 5 Fields
Fields PB-7, PB-8, PB-9, PB-10, PB-16, PB-17, PB-20, PB-23, PB-24, and PB-25 are Category 5 fields. Runoff water from field PB-7 flows into a drained depression in field PB-5. Runoff water from fields PB-7, PB-8, PB-9, and PB-10 flows through a series of drained depressions in field PB-9. The runoff water then flows into the Pleasant Lake Branch Open Ditch. Fields PB-16, PB-17, land PB-20 are drained into drained depressions in Field PB-15. These depressions drain into the Pleasant Lake Branch Tile. Runoff water from fields PB-23, PB-24, and PB-25 drain into a drained depression in field PB-24 which drains into the Pleasant Lake Branch Tile. Field PB-23 is under CRP contract which expires in 1997.

STREAM SAMPLES

Stream samples were collected from the Pleasant Lake Branch Ditch at County Road 25 North. Flows in this ditch normally rise quickly and appear sediment-laden after periods of intense rainfall. The ditch returns to base flow and water appears to clarify within one or two days after rainfall ends. The following are results from laboratory analyses of stream samples:

Parameter	Concentrations	
	Base Flow	Peak Flow
Total Suspended Solids	<5.0 MG/L	635 MG/L
Total Phosphorus	<0.1 MG/L	0.17 MG/L
Total Kjeldahl Nitrogen	<3.0 MG/L	5.0 MG/L

MG/L = Milligrams per Liter

SPECIAL RECOMMENDATIONS

Fields PB-12 and PB-13 contain highly erodible land (HEL) and are adjacent to the Pleasant Lake Branch Open Ditch. These fields are used for cropland and have a history of erosion problems. These two fields should be removed from cultivation.

There are a number of possibilities for wetland restoration within this subwatershed. Wetlands PBW-1, PBW-2 and PBW-3 have excellent topographic potential for restoration under a Lake and River Enhancement Construction Project. Pleasant Lake Branch Ditch is a legal drain and construction projects would affect several property owners. Limitations to developing these wetlands are political and social rather than physical.

Wetlands PBW-4, PBW-5, and PBW-6 could economically be restored by the U.S. Fish and Wildlife Service.

General agricultural land management recommendations are presented on page 57.

NORTH SUBWATERSHED

DESCRIPTION

The North Subwatershed lies directly north of Upper Long Lake. It is the second smallest subwatershed containing only 36 acres (15 hectares). This subwatershed contains 50 percent cropland with 6 acres (3 hectares) of cropland in highly erodible land (HEL).

Most runoff from the North Subwatershed flows to a wetland north of the lake. The wetland is drained by the outlet ditch downstream from Upper Long Lake.

LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	36	15	
Grassland Area	6	3	17
Cropland Area	18	7	50
Wetland Area	5	2	14
Woodland Area	7	3	19
Residential Area	0	0	0
Highly Erodible Land (HEL) Area	11	4	31
Cropland in HEL Area	6	3	17
Conservation Reserve Program (CRP) Area	0	0	0

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields
Field NS-1 is a Category 1 field. Runoff water from the south end of this field drains directly into Upper Long Lake.

Category 2 Fields
There are no Category 2 fields in this subwatershed.

Category 3 Fields
There are no Category 3 fields in this subwatershed.

Category 4 Fields
There are no Category 4 fields in this subwatershed.

Category 5 Fields
Field NS-4 is a Category 5 field. Runoff water from this field flows through field NS-3 and into the drained wetland at the north end of Upper Long Lake.

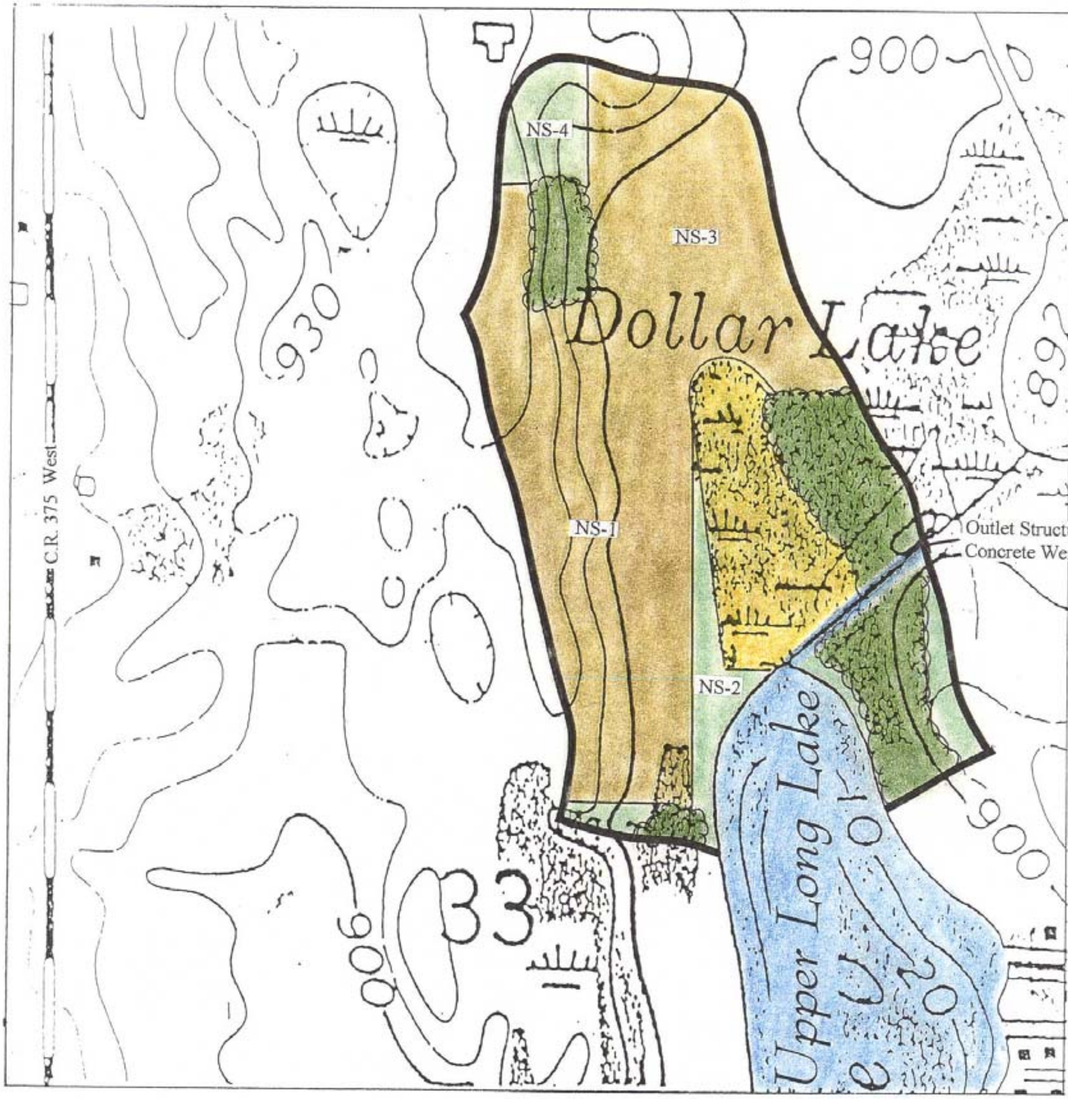
Fields NS-2 and NS-3 contain little or no highly erodible land

STREAM SAMPLES

Flow from the North Subwatershed is not channelized to Upper Long Lake therefore stream samples were not collected from this subwatershed.

SPECIAL RECOMMENDATIONS

There are no special recommendations for this subwatershed. General agricultural land management recommendations are presented on page 57.



Upper Long Lake
North Subwatershed

Cropland Area
Grassland Area
Drained Depression
Residential Area
Water or Wetland Area
Woodland Area

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

NORTHWEST SUBWATERSHED

DESCRIPTION

The Northwest Subwatershed is located northwest of Upper Long Lake and west of the North Subwatershed. This subwatershed contains 23 acres (9 hectares) and is the smallest subwatershed in the Greater Upper Long Lake Watershed. This area is predominantly agricultural with only 4 acres (2 hectares) of cropland in highly erodible land (HEL).

The Northwest Subwatershed consists primarily of a swale drained by a field tile. The tile outlet is lost in a wetland area on the northwest side of the lake.

LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	23	9	
Grassland Area	9	4	39
Cropland Area	7	3	31
Wetland Area	1	<1	4
Woodland Area	6	2	26
Residential Area	0	0	0
Highly Erodible Land (HEL) Area	10	4	43
Cropland in HEL Area	4	2	17
Conservation Reserve Program (CRP) Area	9	4	39

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields
There are no Category 1 fields in this subwatershed.

Category 2 Fields
There are no Category 2 fields in this subwatershed.

Category 3 Fields
Field NW-1 is a Category 3 field. Runoff water from this field flows into drained depressions. These depressions are drained by a tile which discharges into a wetland on the northwest side of Upper Long Lake. Field NW-1 Was under CRP contract until 1996.

Category 4 Fields
Fields NW-2 and NW-3 are Category 4 fields. Runoff water from these fields flows into drained depressions in field NW-1. A tile drains these depressions and discharges into a wetland on the northwest side of Upper Long Lake.

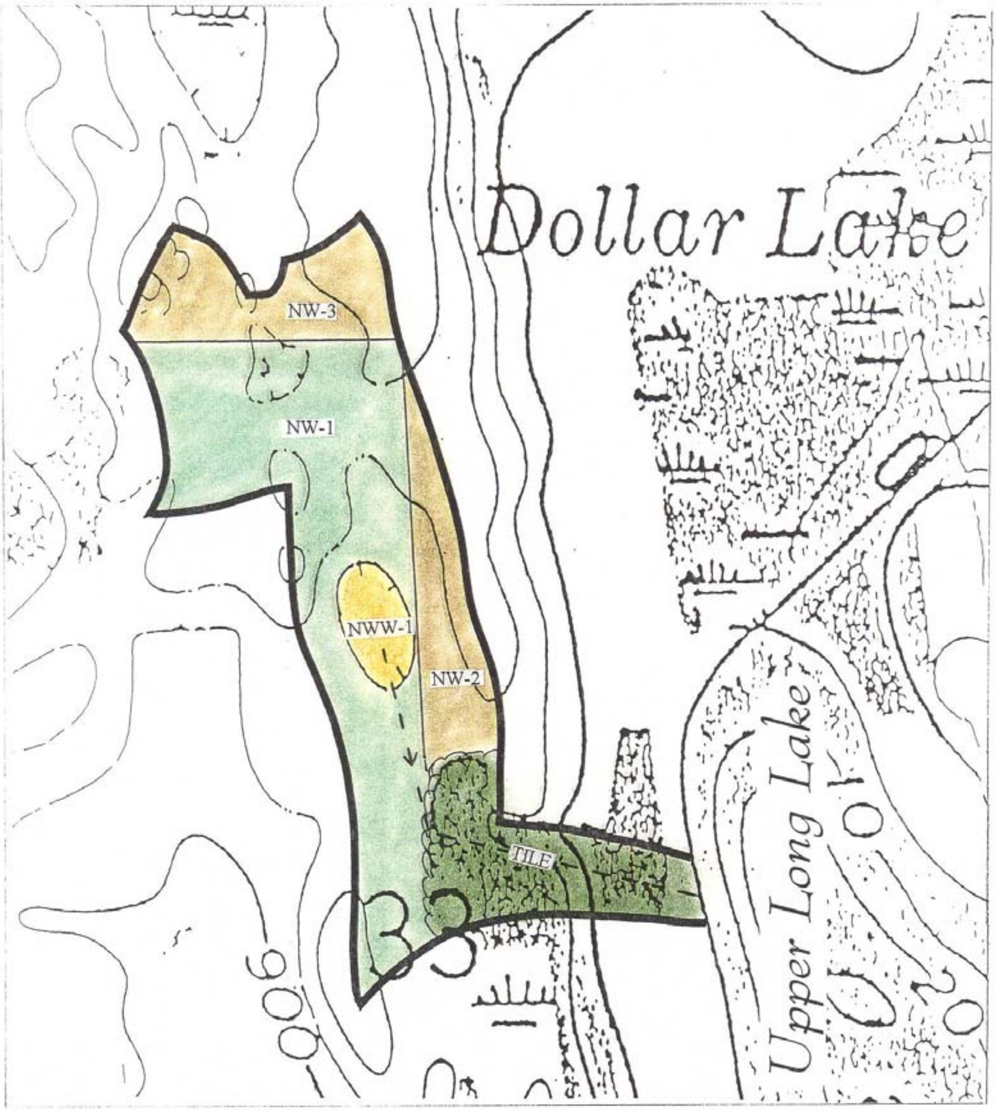
Category 5 Fields
There are no Category 5 fields in this subwatershed.

STREAM SAMPLES

No stream samples were collected from this subwatershed.

SPECIAL RECOMMENDATIONS

There are no special recommendations for the Northwest Subwatershed. General agricultural land management recommendations are presented on page 57.



Upper Long Lake
Northwest Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

N

250' 0 250' 500'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

KIRKPATRICK BRANCH SUBWATERSHED

DESCRIPTION

The Kirkpatrick Branch Subwatershed is located west of Upper Long Lake. The Kirkpatrick Branch Subwatershed contains 260 acres (105 hectares) and is the second largest subwatershed in the Greater Upper Long Lake Watershed. Land use in this subwatershed is primarily agricultural. The subwatershed contains 153 acres (62 hectares) of active cropland and 75 acres (32 hectares) of cropland in highly erodible soils. Approximately 40 feet (12 meters) of relief exists between the main area of cropland west of County Road 375 and Upper Long Lake. Natural swales and tiles which drain this cropland have steep gradients and drain quickly to the Lake.

The northwest area of the Kirkpatrick Branch Subwatershed is drained by an excavated ditch and natural swale which flows generally east from field KK-17 to County Road 375 West. The natural swale passes through an area in field KK-13 which was a farm pond until the dam was removed in the early 1990's. The swale discharges into a corrugated metal pipe under County Road 375 West. The metal pipe discharges to a field tile and open swale which continue to flow east to field KK-4, a low lying muck field. Overland flow continues south as shallow concentrated flow across this field and both overland flow and the tile discharge to the open ditch west of Upper Long Lake.

The southwest area of this subwatershed is drained by grass waterways and a tile which discharges to the open ditch.

The south area of the Kirkpatrick Branch Subwatershed is also drained by a field tile which discharges to the open ditch. The natural drainage swales in the south half of this subwatershed contain terraces constructed to prevent erosion. It is now understood that terraces allow sediment laden runoff to enter field tile which flow directly to an open ditch or lake. The open ditch west of Upper long Lake is shallow, flat, and has vegetated banks. The ditch was dredged in an area of muck soils.

LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	260	105	
Grassland Area	78	32	30
Cropland Area	153	62	59
Wetland Area	1	<1	<1
Woodland Area	16	6	6
Residential Area	12	5	5
Highly Erodible Land (HEL) Area	125	51	48
Cropland in HEL Area	75	31	29
Conservation Reserve Program (CRP) Area	31	13	12

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields

Fields KK-5, KK-12, KK-14, and KK-15 are Category 1 fields. Runoff water from field KK-5 drains into a private tile which discharges into the Kirkpatrick Branch Open Ditch. Runoff water from field KK-12 flows into grass waterways. Terraces collect the runoff water into tiles which discharge into the Kirtpatrick Branch Open Ditch. Fields KK-14 and KK-15 drain into an open ditch. At one time, this ditch was dammed to create a pond, but the dam has been removed. Runoff water in the open ditch flows east under County Road 375 West. The runoff water then flows into a tile and is discharged into the Kirkpatrick Branch Open Ditch.

Category 2 Fields

Fields KK-4 and KK-6 are Category 2 fields. Runoff water from these fields drains into tiles which flow into the Kirkpatrick Branch Open Ditch.

Category 3 Fields

Fields KK-3, KK-10, KK-11, and KK-13 are Category 3 fields Runoff water from fields KK-3 and KK-10 flows directly into the Kirkpatrick Branch Open Ditch. Runoff water from fields KK-11 and KK-13 drain into a tile which discharges into the Kirkpatrick Branch Open Ditch. A dam once made a pond in field KK-13. Fields KK-10 and KK-11 were under CRP contract until 1996.

Category 4 Fields

Fields KK-8, KK-16, KK-17, and KK-18 are Category 4 fields. Runoff water from field KK-8 drains into field KK-5. The water flows into tiles which drain into the Kirkpatrick Branch Open Ditch. Runoff water form field KK-16 flows into field KK-12. The runoff water collects in tiles through the terracing of the field KK-12 swales. These tiles discharge into the Kirkpatrick Branch Open Ditch. Runoff water from fields KK-17 and KK-18 flows into the open ditch at the southwest corner of field KK-17. This open ditch flows through field KK-13, under County Road 375 West, and into a tile south of field KK-11. This tile flows into the Kirkpatrick Branch Open Ditch.

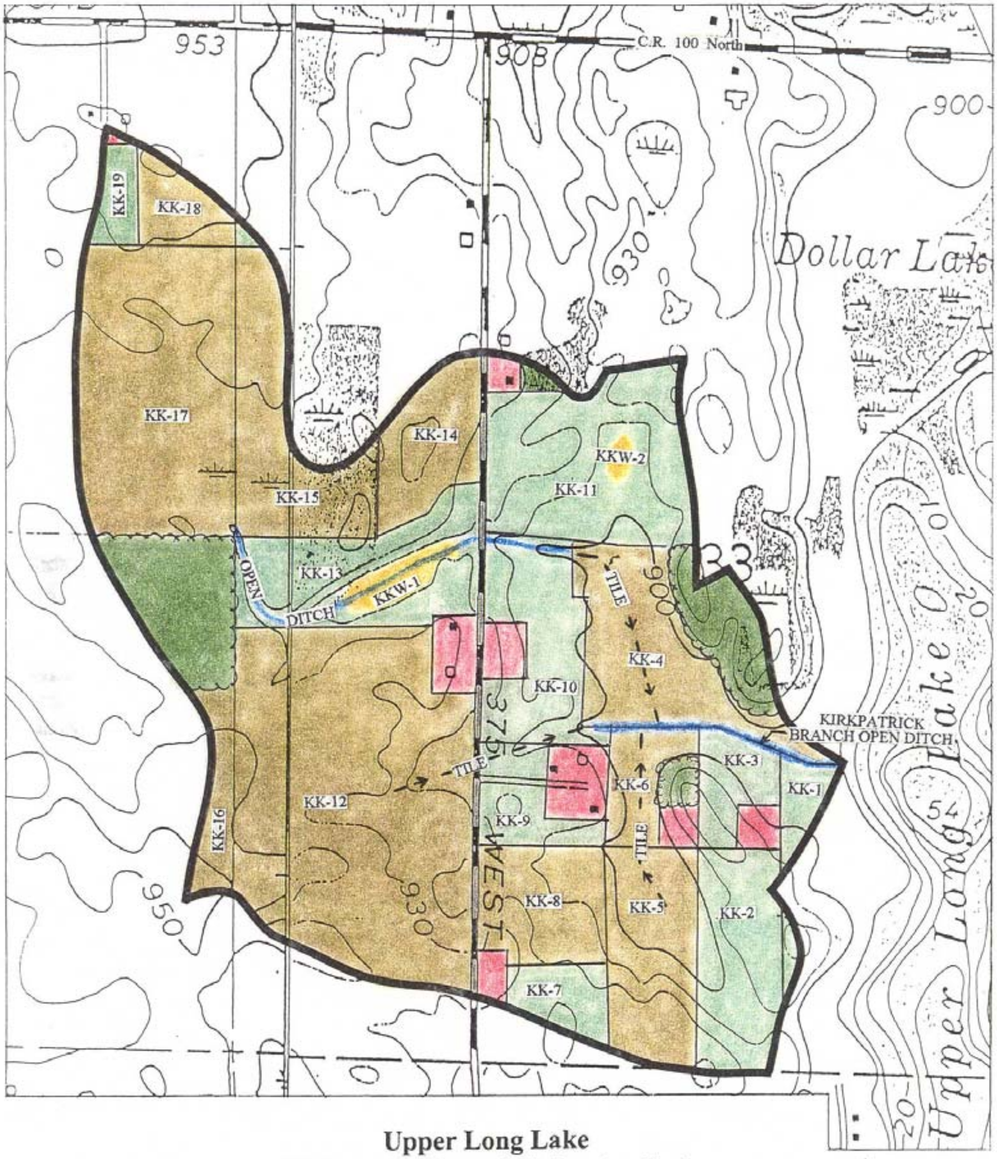
Category 5 Fields

Fields KK-2, KK-7, and KK-19 are Category 5 fields. Runoff water from fields KK-2 and KK-7 drains into field KK-5. This water flows into tiles which drains into the Kirkpatrick Branch Open Ditch. Runoff water from field KK-19 flows through field KK-17 and into the open ditch at the southwest corner.

Fields KK-1 and KK-9 contain little or no highly erodible land.

STREAM SAMPLES

Stream samples were collected from the Kirkpatrick Branch Open Ditch near the outlet to Upper Long Lake. This open ditch is intermittent although it carries low base flows from field tile discharge for



Upper Long Lake
Kirkpatrick Branch Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

500' 0 500' 1000'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

extended periods after sufficient precipitation. The surface water elevation in this ditch is actually lake level. The following are results from laboratory analyses of stream samples:

Parameter	Concentrations	
	Base Flow	Peak Flow
Total Suspended Solids	<5.0 MG/L	1088 MG/L
Total Phosphorus	<0.1 MG/L	0.16 MG/L
Total Kjeldahl Nitrogen	<9.0 MG/L	8.0 MG/L

MG/L = Milligrams per Liter

SPECIAL RECOMMENDATIONS

The drained farm pond west of County Road 375 West in field KK-13 once provided detention for storm runoff for approximately 48 acres (19 hectares) in this subwatershed. The area of this farm pond appears to be wet and not productive as cropland. The pond could easily be reestablished as a pond or wetland to provide detention and sedimentation for runoff from this area of the subwatershed.

A large area of muck field KK-4 could economically be restored as wetland for detention and filtration of runoff from the entire subwatershed. The field is cropland with areas of nonproductive depressions. Efforts to establish detention would require the cooperation of several property owners in this area.

General agricultural land management recommendations are presented on page 57.

SOUTHWEST SUBWATERSHED

DESCRIPTION

The Southwest Subwatershed is located primarily north of County Road 50 South and west of Upper Long Lake. This subwatershed contains 115 acres (47 hectares) and is the fifth largest of the 9 subwatersheds. The Southwest Subwatershed is 72 percent highly erodible land (HEL) and 42 percent of the subwatershed is cropland in HEL. A machine shop and storage yard is located northwest of County Road 50 South and County Road 375 West.

In this subwatershed, surface runoff flows to drained depressions. These historic wetlands are drained by a tile which discharges into the southwest side of Upper Long Lake in Sunset Shores Addition.

LAND USE SUMMARY

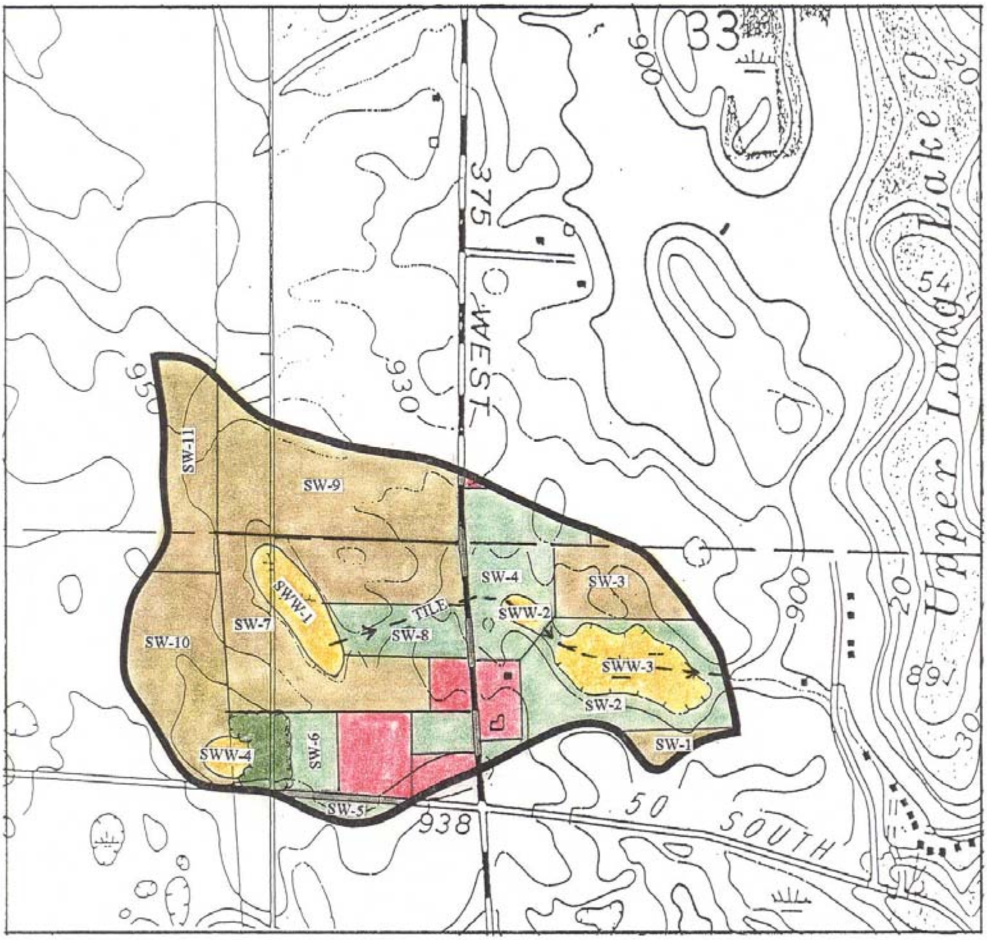
	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	115	47	
Grassland Area	33	13	29
Cropland Area	63	26	55
Wetland Area	3	1	3
Woodland Area	4	2	3
Residential Area	12	5	10
Highly Erodible Land (HEL) Area	83	34	72
Cropland in HEL Area	48	19	42
Conservation Reserve Program (CRP) Area	5	2	4

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields
Fields SW-1, SW-3, and SW-7 are Category 1 fields. The runoff from the west half of field SW-7 flows to a drained depression in field SW-7. A tile carries this runoff water under County Road 375 West, through a drained depression and into Upper Long Lake. Runoff water from fields SW-3 and SW-7 flows into a drained depression in field SW-2. A tile flows from this depression to Upper Long Lake.

Category 2 Fields
There are no Category 2 fields in this subwatershed.



Upper Long Lake
Southwest Subwatershed

Cropland Area
Grassland Area
Drained Depression
Residential Area
Water or Wetland Area
Woodland Area

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

Category 3 Fields
Fields SW-2, SW-4, and SW-8 are Category 3 fields. Runoff from these fields flows into the drained depression in field SW-2, which is drained into Upper Long Lake by a field tile.

Category 4 Fields
Fields SW-9, SW-10, and SW-11 are Category 4 fields. Runoff water from the east half of Field SW-9 flows into the County Road 375 West side ditch. It then flows under the road and into the drained depression in field SW-2. A tile drains this depression to Upper Long Lake. Fields SW-10 and SW-11 drain into the drained depression in field SW-7, which is drained by a tile through fields SW-8, SW-4, and SW-2 and into Upper Long Lake.

Category 5 Fields
Fields SW-5 and SW-6 are Category 5 fields. Runoff water from these fields flows into a pond north of the machine shop. The over flow water from this pond flows into the County Road 375 West side ditch, then it flows under the road and into the drained depression in Field SW-2. A tile drains this depression into Upper Long Lake. Field SW-5 was under CRP contract until 1996.

STREAM SAMPLES

The tile is intermittent and peak flow was sampled at the tile discharge location at Upper Long Lake. The following are results from laboratory analysis:

Parameter	Concentrations Peak Flow
Total Suspended Solids	755.0 MG/L
Total Phosphorus	0.20 MG/L
Total Kjeldahl Nitrogen	4.0 MG/L

MG/L = Milligrams per Liter

SPECIAL RECOMMENDATIONS

Wetland SWW-1, SWW-2, and SWW-3 could be restored by the U.S. Fish and Wildlife Service.

General agricultural land management recommendations are presented on page 57.

SOUTHEAST SUBWATERSHED

DESCRIPTION

The Southeast Subwatershed lies primarily east of County Road 300 West at County Road 50 South. It contains 55 acres (22 hectares) and is the seventh largest of the nine subwatersheds. The Southeast Subwatershed is 95 percent highly erodible land (HEL) and contains 24 percent cropland in HEL. This area is primarily agricultural.

The Southeast Subwatershed is drained by overland flow and a field tile which both discharge to the southeast corner of Upper Long Lake.

LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	55	22	
Grassland Area	35	14	64
Cropland Area	13	5	24
Wetland Area	1	< 1	1
Woodland Area	4	2	7
Residential Area	2	1	4
Highly Erodible Land (HEL) Area	52	21	95
Cropland in HEL Area	13	5	24
Conservation Reserve Program (CRP) Area	36	15	65

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields
There are no Category 1 fields in this subwatershed.

There are no Category 2 fields in this subwatershed.

Category 3 Fields
Fields SE-1, SE-3, and SE-4 are Category 3 fields. Runoff water from these fields flows directly into Upper Long Lake through a swale in field SE-3. Fields SE-1, SE-3, and SE-4 are under CRP contract until 1997.

Category 4 Fields
Field SE-2 is a Category 4 field. The runoff from this field flows under County Road 50 South and

Upper Long Lake
Southeast Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

250' 0 250' 500'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Surv
Contour Interval 10 Feet
Datum is Mean Sea Level

through field SE-3 into Upper Long Lake.

Category 5 Field
There are not Category 5 fields in this subwatershed.

STREAM SAMPLES

Flows in the tile (referred to as the Kohn Tile) are intermittent and peak flow was sampled at the discharge to Upper Long Lake. The following are results from laboratory analysis:

Parameter	Concentrations Peak Flow
Total Suspended Solids	2710.0 MG/L
Total Phosphorus	0.81 MG/L
Total Kjeldahl Nitrogen	11.0 MG/L

MG/L = Milligrams per Liter

Although this subwatershed is small peak tile discharges contained the highest concentrations of contaminants of any of the subwatersheds.

SPECIAL RECOMMENDATIONS

There are no special recommendations for this subwatershed. General agricultural land management recommendations are presented on page 57.

KUHNS BRANCH SUBWATERSHED

DESCRIPTION

The Kuhns Branch Subwatershed is located east of Upper Long Lake and primarily south of Baseline Road. This area contains 101 acres (41 hectares) and is the sixth largest subwatershed in the Greater Upper Long Lake Watershed. This subwatershed is primarily grassland and wetland. The area contains only 8 acres (3 hectares) of cropland, however the cropland is in highly erodible land (HEL) and drains directly into the Kuhns Tile south of the boat channel. Wetlands comprise 21 percent of this subwatershed.

The Kuhns Branch Tile drains this subwatershed. The tile begins west of a wetland area south of Long Lake Road and Baseline Road. The tile flows west through a wetland depression, bends north, crosses Baseline Road and discharges into the south end of the boat channel.

LAND USE SUMMARY

	Acres	Hectares	Percent of Total Subwatershed Area
Total Subwatershed Area	101	41	
Grassland Area	65	26	64
Cropland Area	8	3	8
Wetland Area	21	9	21
Woodland Area	4	2	4
Residential Area	3	1	3
Highly Erodible Land (HEL) Area	74	30	73
Cropland in HEL Area	8	3	8
Conservation Reserve Program (CRP) Area	50	20	50

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Field
Field KB-4 is a Category 1 field. Runoff water from this field flows into a drained depression in field KB-4. This depression is drained by the Kuhns Branch Tile.

Category 2 Field
There are no Category 2 fields in this subwatershed.

Category 3 Field
Field KB-1 is a Category 3 field. The Runoff water from the west half of the field flows into the

Upper Long Lake
Kuhns Branch Subwatershed

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

500' 0 500' 1000'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Survey
Contour Interval 10 Feet
Datum is Mean Sea Level

drained depression in field KB-4. This depression is drained by the Kuhns Branch Tile. Field KB-1 is under CRP contract until 1997.

Category 4 Field
Field KB-5 is a Category 4 field. The runoff water from this field flows into the wetland west of field KB-5, which drains to Upper Long Lake through the Kuhns Branch Tile.

Category 5 Field
Fields KB-2 and KB-3 are Category 5 fields. Runoff water from field KB-2 flows into the wetland to the west of field KB-5, which is drained into Upper Long Lake by the Kuhns Branch Tile. Runoff water from field KB-3 flows under County Road 300 West and into the drained depression on field KB-4. This depression is drained by the Kuhns Branch Tile. Fields KB-2 and KB-3 are under CRP contracts which expire in 1997.

STREAM SAMPLES

The Kuhns Branch Tile carries small flows for extended periods of time but is regarded as intermittent for this report. Storm runoff flow was sampled at the point of discharge just southeast of the south end of the boat channel. The following are results from laboratory analysis of stream samples:

Parameter	Concentration Peak Flow
Total Suspended Solids	106.0 MG/L
Total Phosphorus	0.27 MG/L
Total Kjeldahl Nitrogen	1.0 MG/L

MG/L = Milligrams per Liter

SPECIAL RECOMMENDATIONS

Wetland KBW-2 should be restored to provide detention for runoff from adjacent fields. The permanent water level of wetland KBW-1 could be raised with a water control structure. Both projects could be funded by the U.S. Fish and Wildlife Service.

LAKE SHORELINE AREA

DESCRIPTION

The Lake Shoreline Area is located immediately around Upper Long Lake. This area contains 122 acres (49 hectares) of land is the fourth largest subwatershed in the Greater Upper Long Lake Watershed. The shoreline area contains 60 acres (24 hectares) of highly erodible land (HEL) and there are 6 acres (3 hectares) of active cropland in HEL. Land use in 43 percent of this area is residential. Approximately 40 percent of the Upper Long Lake shore is developed for residential or cottage use.

Runoff in the Lake Shoreline area generally drains directly to the lake without significant concentration or channelization of flows from large land areas. Runoff from Field LS-2 on the west side of the lake is carried by the Cohee Tile and shallow concentrated flow across residential yards directly to the lake . The drainage from this cropland is aggravating to adjacent property owners.

LAND USE SUMMARY

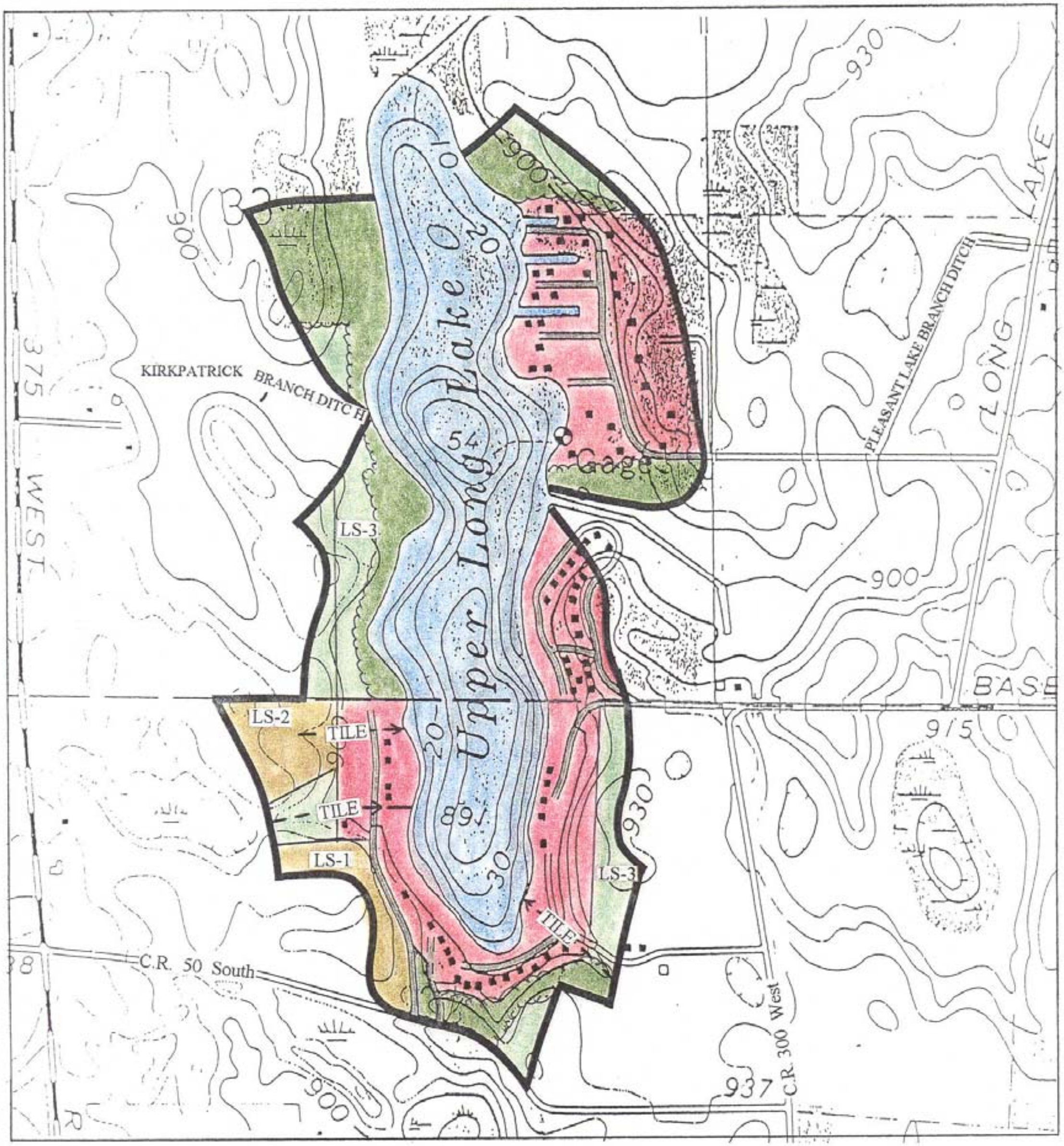
	Acres	Hectares	Percent of Total Subwatershed Land Area
Total Subwatershed Area	207	84	
Upper Long Lake	85	34	
Total Land Area	122	49	
Grassland Area	27	11	22
Cropland Area	10	4	8
Wetland Area	0	0	0
Woodland Area	33	13	27
Residential Area	52	21	43
Highly Erodible Land (HEL) Area	60	24	29
Cropland in HEL Area	6	3	3
Conservation Reserve Program (CRP) Area	7	3	3

FIELD CATEGORIES

Refer to Page 6 for Category descriptions.

Category 1 Fields
Fields LS-1 and LS-2 are Category 1 fields. Runoff water from Field LS-1 flows directly into Upper Long Lake. Runoff water from Field LS-2 flows into a tile which discharges into the west side of Upper Long Lake.

Category 2 Fields
There are no Category 2 fields in this subwatershed.



Upper Long Lake
Lake Shoreline Area

- Cropland Area
- Grassland Area
- Drained Depression
- Residential Area
- Water or Wetland Area
- Woodland Area

N

500' 0 500' 1000'

Map Composite of Ormas & Merriam Quadrangle
United States Department of the Interior Geological Surve
Contour Interval 10 Feet
Datum is Mean Sea Level

Category 3 Fields
Fields LS-3 and LS-4 are category 3 fields. These fields drain directly into Upper Long Lake. Field LS-4 is under CRP contract until 1997.

Category 4 Fields
There are no Category 4 fields in this subwatershed.

Category 5 Fields
There are no Category 5 fields in this subwatershed.

STREAM SAMPLES

The Cohee Tile drains a small cropland area in the west side of the Lake Shoreline Area. The following are results from laboratory analysis of storm runoff flow:

Parameter	Concentrations Peak Flow
Total Suspended Solids	73.0 MG/L
Total Phosphorus	0.31 MG/L
Total Kjeldahl Nitrogen	4.0 MG/L

MG/L = Milligrams per Liter

SPECIAL RECOMMENDATIONS

Detention should be established in Field LS-2. The area of this field which lies within the Lake Shoreline Area should be removed from active cropland and forested. The area of Field LS-1 which drains to the lake should also be removed from active cropland and placed in permanent grass cover or forest.

General Recommendations for the management of Lake Shoreline Area property are presented as a separate section of this report.

RECOMMENDATIONS

INTRODUCTION

Before presenting lists of recommendations it may be important to reiterate a number of the characteristics of the Greater Upper Long Lake Watershed as presented in the Watershed Survey. Natural topographic features and land use practices which contribute to water quality problems in Upper Long Lake are distributed throughout the nine separate subwatersheds comprising the Greater Upper Long Lake Watershed. To target a single subwatershed as the primary cause of lake water quality problems neglects to take into account the cumulative effects of the remaining subwatersheds.

Problems in the Greater Upper Long Lake Watershed are both natural and associated with land use. The land area of the watershed is approximately 58 percent Highly Erodible Land (HEL). Twenty percent of the HEL is currently used as cropland. Over 65 percent of the land area of the watershed is agricultural land, and over 9 percent is developed.

The watershed topography is rolling and many drainage course gradients are steep. Erosion from cropland and erosion in shallow drainage courses are primary contributors of sediment to the lake.

INSTITUTIONAL RECOMMENDATIONS

In a nation of private property owners, conservation and environmentally sound land management are ultimately a local and individual responsibility. Education and awareness are also essential for changing attitudes and establishing an atmosphere for cooperative efforts in the sound management of this watershed. If significant changes in land management or construction projects are undertaken it will be necessary for interested residents to become politically and socially active to successfully implement theses changes. Institutional recommendations are presented below:

1. Open the Upper Long Lake Association's membership to residents of the entire watershed. Stress the watershed-lake relationship. Rename the Association to include the word watershed. A possible example for a name is the Upper Long Lake Watershed Environmental Association. The Association does not need to change the activities it is currently involved with; Environmental is a very encompassing word.

2. Establish an environmental committee within the Association to deal with watershed management issues and projects. Invite a representative of the Noble County Soil and Water Conservation District (SWCD) to serve as an advisor to the committee and a liaison for watershed management issues. A member of the committee should attend SWCD Board meetings to learn more about conservation and watershed management issues.

3. Become active in state and national lake management organizations. These organizations are excellent sources of information. The Indiana Lake Management Society (ILMS) is a state chapter of the North American Lake Management Society

(NALMS). Both organizations coordinate information from lakes in their respective areas and provide news and management information pertinent to lakes. The Midwest Aquatic Plant Management Society is an excellent source of information on identification and control of lake plants. Contact information can be obtained from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement Program.

4. Make environmental education of lake and watershed residents a primary goal of the environmental committee. Acquire a library of literature and video resources regarding lake and watershed management. Include an environmental column in an Association newsletter and encourage the local newspapers to publish articles dealing with local watershed and lake related environmental issues.

5. The Association should encourage local political agencies to enact and enforce zoning and planning regulations for controlling erosion and pollution. "A Model Ordinance for Erosion Control on Sites with Land Disturbing Activities" by the Highway Extension and Research Project, Indiana Cities and Counties (HERPICC) is a helpful guide for enacting an erosion control ordinance. The model ordinance is available from Purdue University, phone number (317) 494-2164.

6. Consider establishing a political entity by the formation of a conservancy district for purposes of funding and maintaining watershed environmental projects. If such an entity is formed it would be possible to purchase environmentally sensitive properties for preservation.

LAKE SHORELINE AREA MANAGEMENT RECOMMENDATIONS

Lakeside property owners should be the people most concerned with water quality in Upper Long Lake. Remember, the best way to preserve clean water is to not get it dirty in the first place. Shoreline Area property owners should not depend solely on someone in the agricultural community taking action to improve runoff water quality flowing to the lake. Shoreline Area property owners should make an effort at sound land management practices as a show of honest concern for the quality of the lake. Listed below are a number of ways to prevent sediments, nutrients, and other contaminants from being transported into the lake by runoff water.

1. Practice temporary and permanent erosion control methods at soil disturbing construction sites. "Indiana Handbook for Erosion Control in Developing Areas" is a very good source of technical information regarding runoff and erosion control for construction sites. This publication is available from the Division of Soil Conservation, Indiana Department of Natural Resources, 402 West Washington Street, Rm. W-265, Indianapolis, IN 46204-2748. The Noble County Soil and Water Conservation District Office is also a source of technical assistance regarding erosion control.

2. Place crushed stone or clean gravel on muddy areas of road shoulders, gravel streets, driveways, and parking areas. A stone cover will reduce erosion of fine solid particles in these areas.

3. Minimize paved and impermeable surfaces which prevent rainfall from soaking into the ground.

4. A lake shoreline area is not the place for maintenance and storage of old vehicles. A protective zoning ordinance would be beneficial in dealing with property use which is detrimental to the lake.

5. Off road recreational vehicles should be operated responsibly and not driven in areas where damage or loss of vegetation will result in soil erosion.

6. Maintain vegetation on steep hills and banks or terrace steep slopes.

7. Maintain and restore natural vegetation buffer zones including trees and bushes along the lake shoreline. These buffer zones filter sediment and nutrients from runoff and provide shade and habitat for wildlife.

8. Recognize the importance of wetlands and depressions in the watershed. Wetlands detain storm waters and filter sediments and nutrients from runoff. Wetlands and depressions also recharge groundwater which flow into the lake as clean spring water. Shoreline wetland areas and shoreline wetland vegetation provide a number of benefits to the lakes. Shoreline wetland vegetation filters runoff water, prevents shoreline erosion, and is an essential element of a healthy lake ecosystem. Do not fill or drain wetlands. Allow the natural establishment of shoreline wetland vegetation along a portion of the lakeshore in front of lake lots. Shoreline alterations can cause significant disruption in critical shallow water areas. Where seawalls are necessary to control erosion, use of glacial stone or rip rap is recommended over concrete or steel materials. Clearing and placement of underwater beaches should be minimized where possible. Use of pea gravel instead of sand for underwater portions of beaches will aid in reducing impacts due to sedimentation and habitat disturbance. Permits are required for all shoreline alteration projects. Information is available from the IDNR Division of Water.

9. Eliminate or minimize fertilization of lawns. What feeds lawns also feeds lake vegetation. If fertilizer must be applied to lawns have the soil tested (not by a fertilizer company) and apply only what is needed. If at all possible do not use fertilizer containing phosphorus. Apply fertilizer only during the growing season and cut grass at the tall setting on the mower. Do not over water the lawn and cause fertilizers to be leached into the lake. Noble County Extension Office (located at the Courthouse Annex - 2090 N S.R.9, Suite D, Albion, Indiana) has soil collection bags and instructions on how to collect soil samples for testing. The telephone number at the Noble County Extension Office is (219) 636-2111. The soil can be taken or mailed

to A & L Great Lakes Laboratories, Inc. at 3505 Conestoga Drive, Fort Wayne, Indiana 46808 to be tested. The telephone number at A & L Great Lakes Laboratory is (219) 483-4759.

10. Compost lawn clippings, leaves, aquatic plants, and organic waste in confined areas where runoff will not leach nutrients into the lake. Recycle nutrient rich compost as fertilizer for gardens and plantings.

11. Do not burn lawn wastes. Confine campfires and burning areas to locations where rainfall will not leach contaminants into the lake. Remove ashes from fire locations and dispose of them in areas away from the shoreline and safe from runoff.

12. If animals must be confined maintain a vegetative buffer area between the confinement area and the lake. Remove excrement from the area frequently. Do not locate confinement areas on steep slopes near the lake or in drainage courses.

13. Do not feed the ducks or geese. Wild ducks and other waterfowl are natural members of the lake community and should be encouraged to remain in the area through preservation of habitat and nesting areas. However, artificial feeding encourages increased populations of semi-domesticated ducks and geese and large waterfowl populations contribute significant amounts or phosphorus to the lake.

14. Purple Loosestrife does not appear to be a problem in this watershed but it should not be introduced and should be exterminated if discovered. This non-native plant is a nuisance and will spread to natural wetland areas where it will crowd out indigenous plant species. It can best be eradicated by herbicides or by digging up the entire plant (including the entire root system), placing it in a bag, and burning it. The sale or purchace of Purple Loosestrife is prohibited in Indiana.

AGRICULTURAL LAND MANAGEMENT RECOMMENDATIONS

It is essential that the Noble County Soil and Water Conservation District (SWCD) assumes an active role in encouraging the implementation of sound agricultural land management practices in the Greater Upper Long Lake Watershed. Members of the Upper Long Lake Association should open lines of communication with the SWCD and educate themselves regarding available land management practices and the process for implementation. A list of land management practices is presented in Appendix C.

In this report the Greater Upper Long Lake Watershed was divided into subwatersheds. Each subwatershed was divided into individual fields and land use areas. Land use areas include active cropland, hay or grassland, woodland, wetland or depressions, and residential or farmstead areas. Agricultural fields, cropland, and hay or grassland were classified into one of five categories. Fields were assigned to a category based on the following criteria:

Category 1 Field
A Category 1 Field contains highly erodible land (HEL) and is currently used as cropland. Runoff from a Category 1 field flows directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 2 Field - A Category 2 Field is a field currently used as cropland which contains little or no HEL. A Category 2 Field discharges runoff directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 3 Field - A Category 3 Field contains HEL and is currently in Conservation Reserve Program (CRP), grass, or hay cover. A Category 3 Field discharges runoff directly into a lake, or open ditch or tile which discharges directly into a lake.

Category 4 Field - A Category 4 Field contains HEL currently used as cropland. A Category 4 Field discharges runoff into a wetland or depression where runoff is detained prior to entering a lake.

Category 5 Field - A Category 5 Field contains HEL currently in CRP, grass, or hay cover. A Category 5 Field discharges runoff into a wetland or depression where runoff is detained prior to entering a lake.

Category 1 Fields are highest on the priority list for land management practices. Tree planting, pasture and hayland planting, critical area plantings, or filter strips should be considered for Category 1 Fields.

Category 2 Fields should be considered for filter strips or critical area plantings.

Category 3 Fields contain highly erodible land (HEL) but are currently in CRP or have a grass or hay cover. No recommendations are made for improvement to land management practices for these fields however it is essential that sound management practices continue to be practiced.

Category 4 Fields should be managed in an environmentally sound manner. These fields were not given the same priority as Category 1 Fields because runoff from a Category 4 Field is buffered prior to flowing to a lake.

Category 5 Fields should continue to be managed in an environmentally sound manner.

Field categories and locations are indicated on the subwatershed maps presented in each subwatershed section of the report.

Property owners should rely on the expertise of SWCD personnel for advice regarding practices. The District Conservationist is knowledgeable and may be very helpful in determining overall sound land management practices and site specific solutions to problems with tile inlets or discharge points.

CONSTRUCTED SOLUTION RECOMMENDATIONS

Constructed solutions include the construction of sediment basins, detention basins, ponds, or the construction or restoration of wetlands. Constructed solutions should not be relied upon for improving runoff water quality in lieu of sound watershed management practices. Remember, the best way to preserve clean water is not to get it dirty in the first place.

Constructed solutions in this watershed should be kept simple and economical. There are many topographic opportunities due to drained wetlands or depressions for the restoration of wetlands to provide runoff detention. Recommendations for constructed solutions are itemized below for each subwatershed:

Pleasant Lake Watershed
There are no constructed solution recommendations for the Pleasant Lake Subwatershed

Pleasant Lake Branch Subwatershed
Wetlands PBW-1, PBW-2, and PBW-3 are adjacent to the open ditch and have excellent topographic potential for restoration to provide for sediment and nutrient reduction for flows in the ditch. The open ditch is a legal drain and these projects would involve several property owners. The restoration of these wetlands could be economical for construction, however restoration may be politically or socially difficult to achieve.

Wetlands PPW-4, PBW-5, and PBW-6 could economically be restored by the U.S. Fish and Wildlife Service.

A sediment basin could be constructed in the Pleasant Lake Branch Open Ditch between County Road 25 North and the boat channel. This watershed contains Morley Blount soils with high clay content. Runoff during peak flows contains fine clay or colloidal particles which may not be effectively trapped by an in-ditch sediment basin.

North Watershed
There are no constructed solution recommendations for the North Subwatershed.

Northwest Subwatershed
There are no constructed solution recommendations for the Northwest Subwatershed.

Kirkpatrick Branch Subwatershed
The drained farm pond west of County Road 375 West in field KK-13 once provided detention for storm runoff for approximately 48 acres (19 hectares) in this subwatershed. The area of this farm pond appears to be wet and not productive as cropland. The pond could easily be re-established as a pond or wetland to provide detention and sedimentation for runoff from this area of the subwatershed.

A large area of muck field KK-4 could economically be restored as wetland for detention and filtration of runoff from the entire subwatershed. The field is cropland with areas of nonproductive depressions. Efforts to establish detention would require the cooperation of several property owners in this area.

Tile risers draining fields should be retrofitted with current practices to prevent sediment laden runoff from directly entering field tile.

Southwest Subwatershed
Wetlands SWW-1, SWW-2, and SWW-3 could be restored by the U.S. Fish and Wildlife Service.

Southeast Subwatershed
There are no constructed solution recommendations for the Southeast Subwatershed.

Kuhns Branch Subwatershed
Wetland KBW-2 should be restored to provide detention for runoff from adjacent fields. The permanent water level of wetland KBW-1 could be raised with a water control structure. Both projects could be funded by the U.S. Fish and Wildlife Service.

Lake Shoreline Area
Detention should be provided in Field LS-2

AGENCIES AND ASSISTANCE PROGRAMS

Technical and/or financial assistance for watershed land and water management projects are available from several public agencies.

Indiana's T-by-2000 Program

The Indiana Department of Natural Resources Division of Soil Conservation administers elements of *T-by- 2000,* including the Lake and River Enhancement program and a cropland erosion control cost-share program. When funds are available, the latter program would be guided locally by the Noble County Soil and Water Conservation District and could provide assistance to agricultural landowners in funding expensive structural erosion control measures on cropland. The Lake and River Enhancement (LARE) program, in addition to having funded this diagnostic study, can potentially provide grants to the lake association for feasibility studies, design plans, or construction projects in the lake's watershed. LARE funds are also available on a competitive basis for watershed-based agricultural land treatment projects which provide cost-shared funds to farmers for implementation of various water quality-oriented resource management practices. For further information contact:

Division of Soil Conservation
Indiana Department of Natural Resources
402 West Washington Street, W-265
Indianapolis, IN 46204
(317) 233-3870
or
Noble County SWCD
100 E Park Drive
Albion, IN 46701
(219) 636-7682

U.S. Department of Agriculture

-Natural Resourses Conservation Service (NRCS)

-Farm Services Agency (FSA)

The USDA offers cost-sharing and technical assistance to farmers through the Conservation Reserve Program, the Wetland Reserve Program, the Wildlife Habitat Incentives Program, the Forestry Incentive Program, and the Environmental Quality Incentive Program. The programs can allow for modifications of existing land uses in the Upper Long Lake watershed that will result in ecological benefits to the lake. Information about these programs can be obtained from the NRCS office, which is co-located with the Noble County SWCD.

Wetland Restoration

The U.S. Fish and Wildlife Service can provide technical services, project management, and funding for the restoration of degraded or drained wetland areas. A representative of the U.S. Fish and Wildlife Service has inspected the proposed restoration sites in the Greater Upper Long Lake Watershed and expressed interest in assisting individual landowners with wetland restoration projects. For further information contact:

U.S. Fish and Wildlife Service
Northern Indiana Sub Office
120 S. Lake Street, Suite 230
Warsaw, IN 46580
(219) 269-7640

Permitting Agencies

Depending on the location or scope of a project construction permits may or may not be required by regulatory agencies.

The United States Army Corps of Engineers, under authority of Section 404 of the Clean Water Act, has jurisdiction over the placement of fill in wetlands. If a project requires construction in a wetland contact:

Attention NCECO-L
Regulatory Branch
Detroit Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231-1027
(313) 226-2218

The Indiana Department of Natural Resources (IDNR) has jurisdiction over construction activities in a public freshwater lake or a floodway. The IDNR should be contacted before beginning any work in and around the shoreline of a lake or on ditches draining into the lake as a permit may be required.

A permit is required if excavation is proposed in a lake or below lake level in an inflowing channel. A permit is also required if construction of a dam meets any of the following criteria:

1. The drainage area above the dam is more than one square mile.

2. The height of the dam above the stream bed is more than 20 feet.

3. The volume of water impounded by the dam is more than 100 acre-feet.

4. The impoundment affects more than one property owner.

For further information contact:

Indiana Department of Natural Resources
Division of Water
402 West Washington St. Room W 264
Indianapolis, IN 46204
(317) 232-4160

The Kirkpatrick Branch and Pleasant Lake Branch open ditches and tiles are regulated drains. Construction affecting a regulated drain must be permitted by the Noble County Drainage Board. For further information contact:

Noble County Drainage Board
Noble County Office Complex South
2090 North S.R. 9, Suite B
Albion, IN 46701
(219) 636-2131

Classified Wildlife Habitat Act

The Indiana Department of Natural Resources Classified Wildlife Habitat Act (CWHA) provides property tax savings for areas of 15 acres of larger reserved for wildlife habitat. Land enrolled in the CWHA may not be used for farming or grazing or contain buildings. The property owner maintains control of the acreage for such purposes of hiking, hunting, or firewood cutting, but is not required to allow public access to the property. For further information concerning the Classified Wildlife Habitat Act contact:

IDNR Division of Fish and Wildlife
305 North Meadow Lane
Kendallville, IN 46755
(219) 347-2945

UPPER LONG LAKE
CURRENT WATER QUALITY

UPPER LONG LAKE CURRENT WATER QUALITY

MATERIALS AND METHODS

CALCULATION OF THE IDEM EUTROPHICATION INDEX FOR 1992

The calculation used to construct the Indiana Department of Environmental Management (IDEM) Eutrophication Index in 1975 was based on summertime conditions. Therefore, we gathered data on August 31, 1992 and September 24, 1992 for phytoplankton. The following parameters were sampled to calculate the IDEM Eutrophication Index for Upper Long Lake.

1. Total Phosphorus (TP)
2. Soluble Phosphorus
3. Organic Nitrogen
4. Nitrate Nitrogen
5. Ammonia Nitrogen
6. Dissolved Oxygen (% saturation at 5' depth)
7. Dissolved Oxygen (% water column with at least 0.1 ppm dissolved oxygen)
8. Light Penetration with a Secchi disk
9. Light Transmission (% at 3' depth)
10. Total Plankton/liter of water sampled
    a. one vertical tow from five feet to surface
    b. one vertical five feet tow which includes the beginning of the thermocline

The sampling station was located at the deepest part of the lake (54', see Figure W 1). Sampling was done in August and September when the lake was still stratified. Dissolved oxygen (DO) and temperature readings were taken at 3' intervals from the surface to the bottom of the lake. The Secchi disk reading was taken from the shaded side of the boat between the hours of 9:00 a.m. and 3:00 p.m. as recommended in the APHA manual (1989). A photocell was not available for measuring light transmission so an estimation was made based on the Secchi disk transparency. The equations for the estimate were obtained from Ms. Kelly Boatman of the Indiana Department of Natural Resources (IDNR) Office of Soil Conservation. The equations are in Appendix F. A Van Dorn sampling bottle was used to obtain epilimnion and hypolimnion water samples at approximately three feet below the surface and three feet from the lake bottom. The hypolimnetic sample was taken in a manner which avoided collection of sediment. The epilimnetic and hypolimnetic samples were analyzed separately for the following chemical parameters:

1. Total Phosphorus (TP)
2. Soluble Phosphorus
3. Organic Nitrogen (TKN minus NH_3-N)
4. Nitrate Nitrogen (NO_3-N)
5. Ammonia Nitrogen (NH_3-N)

Dissolved oxygen was determined in the field by Method 4500-O/Azide Modification (APHA,1989). Plankton were collected with a Birge-type plankton net. All plankton collected were preserved with Lugol's solution. The plankton were quantified and identified in the laboratory using the Sedgwick-Rafter Counting Procedure (APHA, 1989). We also measured alkalinity and pH values for comparison with any available historical data.

The water and sediment chemistry values reported in the tables are averages of the duplicated samples taken for each parameter.

QA/QC PROCEDURES DURING SAMPLING

Chain-of-custody sheets were used to document the procedures and to permit tracing of samples from their collection through their acceptance at the analytical laboratory. For each parameter, samples were collected following the procedures outlined in APHA (1989). In the field, a trip (field) blank was collected for use during analysis of the parameters. Duplicate samples were taken for each parameter. Water samples were kept in polyethylene containers and were preserved following the guidelines of APHA (1989). Sediment samples were placed in glass jars. Dissolved oxygen samples were placed in 300 mL BOD bottles. Phytoplankton samples were preserved with Lugol's solution combined with buffered formalin. The following preservatives were used for the samples:

Parameter	Preservative
Nitrates	2.0 mL H_2SO_4/L, sample kept @ 4° C
TKN (Total Kjeldahl Nitrogen)	0.8 mL H_2SO_4/L, sample kept @ 4° C
Ammonia	0.8 mL H_2SO_4/L, sample kept @ 4° C
Total Phosphate	samples were frozen
Soluble Phosphate	samples were frozen
Sediment	samples were kept @ 4° C

SEDIMENT ANALYSIS

An Ekman dredge was used to obtain bottom samples from the deepest part of the lake. The samples were analyzed for total phosphorus and total Kjeldahl nitrogen (TKN) to determine the availability of nutrients in the lake sediment.

ESCHERICHIA COLI BACTERIA

A sample for *Escherichia coli (E. coli)* bacteria was collected at one station in Upper Long Lake. It was analyzed in accordance with the guidelines of the Indiana State Department of Health. *E. coli* levels are important in assessing the impact of septic tank effluent as a potential lake contaminant.

COMPILATION AND SYNTHESIS OF PAST WATER QUALITY DATA

A search for past water quality data turned up no records in the Noble County Health Department and few records elsewhere. The best source for historical water quality data was the IDNR Tri-Lakes Fisheries Station. The only water quality studies ever done on Upper Long Lake have been performed by the IDNR usually as part of their fish surveys of the lake or by IDEM as part of their trophic classification studies. Mr. Jed Pearson, fisheries biologist, was extremely helpful and knowledgeable concerning the water quality and other studies done on Upper Long Lake. Unfortunately, there are no historical data for Upper Long Lake which go back in time significantly. In fact, the first water quality study of Upper Long Lake was not performed until 1972. All other water quality studies have been done since 1972.

AQUATIC MACROPHYTES AND ALGAE (PLANTS)

A survey of the aquatic macrophytes was performed in order to determine if they posed any problems for the lake. The aquatic macrophytes were identified (to species level when possible) and their distribution around the lake was mapped. Such information will prove important if any control of the plants is required. However, it should be noted that aquatic macrophytes play vital roles in trapping nutrients loaded to the lake; serving as habitat for fishes, waterfowl and other animals; and they can even sequester heavy metals (Scribailo, unpublished).

FISH POPULATIONS

Historical information on the fish populations in Upper Long Lake was obtained from IDNR fish management reports. The IDNR Tri-Lakes Fisheries Station proved to be an invaluable resource of these data. Once again, Mr. Jed Pearson was very helpful in providing the available reports for Upper Long Lake. However, as with the water quality reports, the fish surveys have all been done during the last two decades. Therefore, there are no long-term historical data available for comparison with current data. Lack of such historical data will make it more difficult to predict the relative effects of eutrophication control on future fish populations.

FIELD PARAMETER RESULTS

WATER QUALITY & CALCULATION OF THE IDEM EUTROPHICATION INDEX FOR 1992

The laboratory analyses data from which the Eutrophication Index was calculated are contained in Appendix H. The 1992 Indiana Department of Environmental Management (IDEM) Eutrophication Index value was 34 (Table L1). The previous value for the mid-1970's and 1988-89 was 32. Therefore, there has been little change over time and the lake has not become significantly more eutrophic. Additionally, water quality data from 1972 through 1992 are consistent from study to study (Tables L2, L3, & L4; Appendix G) and further support the contention that little change has occurred during the last two decades. Although the Eutrophication Index value was slightly higher in 1992, Indiana Department of Natural Resources (IDNR) does not consider the difference to be significant if it is within 10 points of a previous value (K. Boatman, IDNR, pers. comm.). Although the water quality has changed little during the last two decades, periodic calculation of the Eutrophication Index should be done to determine if there is any significant change in the water quality.

Table L1. IDEM Eutrophication Index for Upper Long Lake for 1992.

Parameter	Value	Eutrophy points
Total Phosphorus (ppm)	0.23	4
Soluble Phosphorus (ppm)	0.25	4
Organic Nitrogen (ppm)	0.54	1
Nitrate (ppm)	<0.10	0
Ammonia (ppm)	0.62	3
Dissolved Oxygen (% saturation @ 5' from surface)	64%	0
Dissolved Oxygen (% of measured water column with at least 0.1 ppm DO)	70%	1
Light Penetration (Secchi Disk)	5.5'	0
Light Transmission (% @ 3' depth) (Estimate from Secchi Disk Transparency)	39.8%	3
Total Plankton/L	26826/L	3
blue-green dominance	Yes	5
thermocline	5428/L	5
blue-green dominance	Yes	5
> 95,000 cell/mL	No	0
Calculated Eutrophication Index		34

Sample dates for the data in Table L1 are August 31, 1992 and September 24, 1992 for phytoplankton.

Table L2. Water Chemistry Values For Upper Long Lake For 1992

Parameter	Value
Secchi Disk	5.5'
Ammonia	0.62 mg/L
Total Kjeldahl N	1.16 mg/L
Organic-N	0.54 mg/L
Nitrate	<0.10 mg/L
Total Phosphorus	0.23 mg/L
Ortho Phosphorus	0.22 mg/L
Conductivity	376.00 mS/cm (umho/cm)
Total Alkalinity	538.00 mg/L (as $CaCO_3$)
pH	8.14

Table L3. **Temperature & Dissolved Oxygen Values for Upper Long Lake for 1992**

Depth (ft.)	Temperature (F)	DO (mg/L)	% Saturation
surface	70	6.36	73.0
3	70	6.68	77.0
5	70	5.58	64.0
6	69	4.84	54.8
9	67	4.23	47.0
12	67	2.93	33.0
15	64	2.04	22.0
18	62	1.16	12.0
21	60	1.07	11.0
24	56	0.48	4.6
27	56	0.38	3.7
30	55	0.27	2.6
33	54	0.16	1.5
36	53	0.25	2.3
39	51	0.00	0.00
42	51	0.00	0.00
45	51	0.00	0.00
48	50	0.00	0.00
51	46	0.00	0.00
bottom	51	0.00	0.00

Table L4. **Morphometric and Trophic Characteristics of Upper Long Lake (1988 - 1989)**

Trophic Class	2
Size (acres)	86
Maximum Depth (ft)	54
Mean Depth (ft)	22.1
Total Phosphorus (μg/L)	0.17
Secchi Disk (ft)	7.0
Eutrophication Index	32
Lake Management Group	Via

As found in previous work done on Upper Long Lake, the phytoplankton community was dominated by blue-green algae (Table L5). This was true for the phytoplankton near the surface and for those samples at the thermocline. The species of blue-green algae made up 84.1% of the total phytoplankton found in the near-surface sample and 64.2% of the thermocline sample. The most commonly found species at the surface and the thermocline was *Aphanizomenon*. Blue-green dominance is not unusual in a lake such as Upper Long Lake.

Table L5. **Phytoplankton Composition (in percent) in Upper Long Lake for 1992**

Species	Surface	Thermocline
Aphanizomenon	71.2%	60.3%
Anabaena	12.1%	0.8%
Lyngbya	0.7%	3.1%
Synedra	7.1%	15.3%
Zygnema	1.8%	13.5%
Ceratium	3.0%	4.8%
Fragillaria	0.4%	-------
other green algae	3.6%	1.7%
other blue-green algae	------	0.4%

SEDIMENT ANALYSIS

Table L6 contains the data for total Kjeldahl nitrogen (TKN) and total phosphate (TP) for the sediment samples. The value for TKN is probably typical of a nutrient-rich sediment at the bottom of a lake such as Upper Long Lake, but there are no historical data or data from other lakes for comparison The value for total phosphate (TP) is very low. Compared with a value for Lake Tippecanoe and other Indiana lakes (IDNR, 1997) total phosphate in Upper Long Lake is virtually nonexistent. Therefore, it appears that the sediment of Upper Long Lake does not contain excessive nutrients.

Table L6. Sediment Sample Chemistry Values for Upper Long Lake for 1992

Parameter	Value
Total Kjeldahl N	689.00 mg/L
Total Phosphate	2.12 mg/L

ESCHERICHIA COLI BACTERIA

Table L7 presents the data for *E. coli.* Two colonies were found in the 100 mL sample, but no colonies were found at the lower volumes. The acceptable level for *E. coli* in surface water is 235 colonies/100 mL. Therefore, the results for Upper Long Lake were acceptable.

Table L7. *Escherichia coli* Values for Upper Long Lake for 1992

Dilution	Colonies
0.1 mL	0
1.0 mL	0
10.0 mL	0
100.0 mL	2

AQUATIC MACROPHYTES AND ALGAE (PLANT SPECIES INVENTORY)

MACROPHYTIC ALGAE

Characeae

Chara globularis (stonewort)

ANGIOSPERMS

Monocotyledons-

Alismataceae

Sagittaria latifolia (common arrowleaf)

Potamogetonaceae

Potamogeton nodosus (pondweed)
Potamogeton confervoides
Potamogeton zosteriformis (flatstem pondweed)
Potamogeton crispus (curlyleaf pondweed)
Potamogeton robbinsii

Najadaceae

Najas flexilis (water naiad)
Najas gracillima

Typhaceae

Typha latifolia (common cattail)
Typha augustifolia (narrow-leaved cattail)

Pontederiaceae

Pontederia cordata (pickerel weed)

Cyperaceae

Scirpus americanus (American bulrush)
Carex aquatilis

Nymphaeaceae

Nuphar variegatum (yellow water lily)
Nymphaea odorata (white water lily)

Ceratophyllaceae

Ceratophyllum demersum (coontail)

Halorigidaceae

Myriophyllum exalbescens (northern water milfoil)

Polygonaceae

Polygonum persicaria

Crassulaceae

Penthorum sedoides (ditch stonecrop)

Cornaceae

Cornus stolonifera (red-osier dogwood)

Compositae

Eupatorium purpureum (joe-pye weed)
Bidens cernua (beggars-ticks)

The aquatic plant community of Upper Long Lake represents a typical species assemblage characteristically found on alkaline substrates. The distribution of all *Chara* species is largely governed by pH and they are typically abundant in oligotrophic lakes (Hutchinson, 1975). Almost all are found above pH 6.0 but are most common at higher pH. *Chara globularis* favors a pH range of 5.0-9.6. All *Chara* species (as do many submerged aquatic plants) have the ability to uptake HCO_3^- (bicarbonate) as an alternative carbon source to gaseous CO_2. A byproduct of this process is the deposition of calcium carbonate ($CaCO_3$) on the surface of the leaves. It is this material that forms much of the flocculent precipitate present as substrate in the lake.

The submerged aquatic plant flora of Upper Long Lake is characterized by species which are capable of utilizing bicarbonate as a photosynthetic carbon source. This includes all of the submerged aquatic plant species listed from the lake (all Potamogetonaceae and *Myriophyllum exalbescens*).

Generally, increasing the diversity of littoral habitat increases the diversity of organisms at each trophic level (Wetzel, 1975). Thus an increase in diversity of habitat types would mean increases in breeding sites for fish populations. Increases in biomass associated with eutrophication usually result in increased invertebrate populations as food sources for fish.

Sunfish (both bluegills and pumpkinseeds) are characterized by two-stage life-histories (Osenberg, Mittelbach and Wainwright, 1992). Both types of sunfish feed on littoral invertebrates as juveniles (<45mm). At approximately 75 mm a dietary shift occurs with pumpkinseeds shifting to predation on snails and bluegills feeding predominantly on zooplankton. Intermediate transitional size classes of these fish have a mixed diet (Osenberg, Mittelbach and Wainwright, 1992). Both bluegills and pumpkinseeds compete for a limited resource as juveniles.

As adults, feeding by bluegills occurs predominantly on *Daphnia* in deeper water limnetic zones in July and August and it is ingestion of these optimal prey that leads to rapid size increases in bluegills (Mittelbach, 1981). Data for population sizes and species diversity of *Daphnia* (as well as that for other zooplankton) in both littoral and limnetic communities would be very informative for Upper Long Lake. Absence of higher size classes of bluegills could be a direct reflection on depauperate populations of zooplankton.

If there is an interest in increasing the size of pumpkinseeds then data on snail populations from plants collected in the littoral zone would give an idea of food resources for these fish. Snail populations are directly affected by calcium concentration (Lodge et al., 1987) which is typically high in marl lakes having extensive calcium carbonate deposition on the leaves of submerged aquatic plants.

Possibly the most informative avenue of investigation would be to examine gut contents of sunfish and pumpkinseeds of various size classes to directly screen dietary uptake. Both species as adults selectively prey on snails or zooplankton if available, primarily on the basis of size of prey (Mittelbach, 1981).

All of the submerged aquatic plants in Upper Long Lake provide excellent substrate for epiphytic algae which in turn can act as a food source for invertebrates thus providing an important link in the food chain. The dominance of *Chara* in the lake is a reflection of the high levels of bicarbonate in the lakes and consequent high total alkalinity. *Chara* also grows very rapidly and it may continue growing under shallow ice during the winter. If conditions are severe enough the shoot apices of *Chara globularis* may go dormant in the winter but grow extremely rapidly in the early spring. *Chara globularis* can also reproduce asexually by fragmentation and through the production of bulbils (Wood, 1965).

It appears of some significance that some of the largest pondweed populations in the lake (although all are rare) are closest to the southern end of the lake where *Chara globularis* is less abundant. The *Potamogeton* spp. are also more abundant in the inlet area on the central eastern area of the lake. To increase diversity and population size of these pondweeds it may be beneficial to consider removal of some parts of the *Chara* populations adjacent to these pondweed beds.

In terms of weed potential of *Chara*, evidence suggests that, although *Chara* is abundant in shallow water, that it will not cause the kinds of weed problems seen with species such as *Myriophyllum spicatum* because it will seldom grow more than a foot high and typically forms a "carpet" on the bottom.

Along the Southwestern side of the lake there are several nice diverse populations of emergent aquatic plants including *Polygonum, Sagittaria* and a number of sedges which should be preserved. These provide valuable buffer strips for trapping sediment and nutrients before they reach the lake.

FISH POPULATIONS

No fish survey was done during this study because the IDNR Tri-Lakes Fisheries Station had been doing periodic surveys for over a decade. The most recent survey was done in 1995. The information from these surveys is summarized in the section of the report dealing with historical lake information. Copies of the actual reports are contained in Appendix G.

UPPER LONG LAKE HISTORICAL DATA

METHODS

Historical data on Upper Long Lake were collected from Indiana Department of Environmental Management (IDEM) reports, Indiana Department of Natural Resoures (IDNR) reports, and discussions with a county health department official. The IDNR Tri-Lakes Fisheries Station and the station's fisheries biologist (Mr. Jed Pearson) provided much historical data for Upper Long Lake. All of the available historical data for Upper Long Lake were found at the station.

There is little historical information available for Upper Long Lake. For example, the first water quality study for Upper Long Lake was done in 1972 by the IDNR. The first fish population survey was done in 1980 by the IDNR. No earlier studies could be found.

WATER QUALITY STUDIES

The first water quality study done on Upper Long Lake was performed by Mr. Melvin Taylor of the IDNR during 1972. This study was performed to determine if Upper Long Lake could serve as a coldwater (trout) fishery. The results of the study suggested that the lake would be marginal at best for trout stocking and therefore Upper Long Lake should not be considered as a potential coldwater fishery. The general picture of the lake presented by this study was that of a lake which exhibited seasonal thermal stratification, moderate clarity, alkalinity, anoxia in the hypolimnion and good water quality.

Other water quality studies, since the initial study, have been performed as part of IDNR fish surveys and as part of the IDEM trophic classification studies. These various reports suggest that water quality in Upper Long Lake is good and has not changed significantly over the last two decades. The lake's IDEM Eutrophication Index was 32 during the mid-1970s and also 32 during the late 1980s. Several individual water quality reports are presented in Appendix G.

ESCHERICHIA COLI BACTERIA

Escherichia coli (E. coli) bacteria are normally found in the large intestines of humans and other endotherms and make up a large proportion of the feces which result from the digestive activities of the intestinal tract (Marieb, 1995). If these bacteria are found in high numbers in surface water such as lakes there exists the possibility that untreated sewage is entering the lake.

In a discussion with Mr. Jack Chronister of the Noble County Health Department it was determined that no problems with high levels of *E. coli* bacteria had ever been reported. Apparently, sewage runoff or other sources of *E. coli* have not posed any historical problems in Upper Long Lake.

AQUATIC MACROPHYTES AND ALGAE

Historical reports of aquatic macrophytes and algae were found in the fish surveys done by the IDNR. Additionally, anecdotal information from lake residents suggested that "weed" (macrophyte and algal) growth increased markedly during the late 1970s, but no scientific studies were done to verify these anecdotes. Weed control permits have been issued on a more or less yearly basis by the IDNR since the mid-1980s as residents have attempted to control growth of aquatic macrophytes and algae.

Beginning with the 1980 fish survey by the IDNR, the various species of aquatic plants have been identified and their approximate densities determined. These plants and algae can be roughly classified as being submergents or emergents. The most abundant submergents found have been *Chara* and coontail. Another submergent found was Sago pondweed (rare). Commonly found emergents were cattail, white lily, and yellow lily. Found rarely were bulrush and pickerelweed. Between the 1980 survey and the 1991 survey spatterdock increased its coverage in Upper Long Lake from rare to common. Northern milfoil was common during the 1980 survey, but was not found during the 1991 survey. However, milfoil was again found in our 1992 survey of the plant populations.

Upper Long Lake has a patchwork distribution of aquatic plants of intermediate diversity for oligotrophic lakes. This distribution is important to the natural character of the lake and provides important fish habitats. Although some lakes and wetland areas of Indiana are experiencing an influx of exotic plants such as purple loosestrife, this was not a problem at Upper Long Lake (at least through 1991).

The 1991 survey documented the presence of significant wetland areas along the west and north shores of the lake. The report emphasized the need for maintaining these wetlands which provide numerous benefits to Upper Long Lake. Additionally, it was recommended that control of aquatic macrophytes be limited to small areas less than 25 feet wide near piers and beaches. Limiting control to these areas maintains a more natural lake bottom and provides adequate fish habitats.

FISH POPULATIONS

Unlike some other lakes in Indiana, there are no fish population surveys for Upper Long Lake prior to 1980. The only information available was a water quality report the IDNR did in 1972 and anecdotal reports from local fishermen. Due to this lack of data no long-term historical trends for the fish populations can be discerned for Upper Long Lake.

Although there is lack of formal studies of fish populations, the overall impression gained from anecdotal information is that the quality of bluegill fishing has declined in Upper Long Lake. To the local fishermen, reduced quality of bluegill fishing means that few large bluegills are caught although many smaller ones may be caught. Local residents and fishermen believe that the reduced quality of bluegill fishing occurred as the amount of *Chara* increased in the lake.

To try to address these concerns, personnel from the IDNR Tri-Lakes Fisheries Station have done several fish surveys over the last 17 years. These surveys have been conducted mainly by Mr. Jed Pearson, the fisheries biologist at the station. The information and recommendations below were obtained from these surveys done by Mr. Pearson.

The first IDNR fish survey on Upper Long Lake was done in 1980. This survey first documented the slow growth rate of bluegills in Upper Long Lake. The verification of the slow growth rate supported the anecdotal evidence from fishermen that there were many small bluegill, but fewer than expected large bluegill. Although the causes of the poor bluegill growth rate were not discovered, it was thought that perhaps the food supply was insufficient or there were too few predator fishes in the lake.

Mr. Pearson recommended thinning the population of bluegill and stocking largemouth bass to try to improve the growth rate of the bluegills. To thin the bluegill population, Mr. Pearson recommended using antimycin which selectively kills smaller bluegill. The antimycin treatment was done during 1981. Follow-up studies have been done since that time to determine if the antimycin treatment had any long-term beneficial consequences for bluegill fishing.

The followup studies were done in 1987, 1991, and 1995. These studies showed that initially the antimycin treatment had the desired effect of reducing the numbers of small, slow-growing bluegills. Larger bluegill were caught by the fishermen after the treatment with antimycin. Additionally, the numbers of non-target fish did not show any significant change and the number of largemouth bass increased as a result of stocking. However, the improvements in bluegill size and growth rate were not maintained over time. Six years after treatment bluegill sizes were similar to pretreatment averages. Although the population in 1987 contained larger bluegills than in 1980 these were fish which had grown rapidly during the first years after antimycin treatment. As these older fish died the mean length of bluegill declined. Unfortunately, the stocking of largemouth bass did not lead to enough predation to control the bluegill population. The follow-up studies also indicated that the growth rates for other sunfish species and largemouth bass were also slower than normal.

The exact conditions which are causing the slow growth rate of bluegills have still not been determined. Two possible causes which have been suggested are (1) insufficient food for the fish and

(2) lack of predator fish to reduce the number of bluegill allowing the survivors to find more food and grow faster. Another possible reason for the large number of small bluegill is the presence of dense beds of *Chara* in Upper Long Lake. These beds of *Chara* provide excellent escape cover for the young bluegill which prevents them from being preyed upon by the predator fish. These possibilities gain in credibility when one notes that nearby Pleasant Lake and Lower Long Lake have better bluegill growth rates and these lakes have larger predator fish populations and do not have the dense beds of *Chara*.

It should be noted that these possible causes are merely speculative and further study needs to be done to determine the exact causes of the slow bluegill growth rate. Unfortunately, the IDNR does not have sufficient time or money to do the type of studies which would be required to determine the causes. One action taken by the IDNR which was hoped to increase the predator fish population is the imposition during 1990 to a 12 inch minimum size limit for largemouth bass. However, the 1995 survey suggested that the 12 inch limit for largemouth bass was not having any impact on bluegill growth.

Finally, the IDNR does not have records or reports of extensive fish kills, fish contaminations, or fish consumptions advisories for Upper Long Lake during 1988-89 or other years. These types of reports occur when fish are exposed to pollution or other factors which adversely affect their populations or their suitability for human consumption.

CONCLUSIONS / RECOMMENDATIONS

WEED MANAGEMENT

At this point in time there are no problem weed species in Upper Long Lake that have extensive biomass production. Although *Chara globularis* covers a significant area of the littoral zone it is does not negatively impact the biotic integrity of the lake. The plant could be removed in patches to allow space for colonization of a greater diversity of species, some possibly introduced as tubers of native pondweeds for example. It may be worthwhile to "seed" the lake with tubers of select aquatic plant species without disturbance to increase habitat diversity. Studies indicate that disturbance could favor establishment of eurasian milfoil (*Myriophyllum spicatum*) (Smith and Barko, 1990). The only other aquatic plant species of abundance is *Ceratophyllum demersum* near inlets to the lake on the west side with it's distribution indicating some nutrient loading.

Blue-green algae such as *Aphanizemenon* do not indicate high nutirent loading since the genus usually occurs in productive waters with low N and P during the warmest part of the summer. It is typically predominant when turbidity is low and illumination is high (Hutchinson, 1967).

The only recommendations would be to install sediment traps on inlets to prevent excessive loading and to protect marginal wetland areas that can act as buffer strips and filter out nutrients and sediment. Residents should be encouraged to plant buffer strips along the shoreline rather than mowing grass to the edge of the lake. Many attractive flowering wetland species such as Iris, Arrowhead, Bur Reed and sedges can form a functional border of this type.

Ironically, additional loading of organic matter and nutrients could very well increase productivity of phytoplankton.

FISH MANAGEMENT

The primary fish management issue in Upper Long Lake remains the slow growth of the bluegill. This phenomenon is also seen in the largemouth bass population but to a lesser extent. The first fish survey of Upper Long Lake in 1980 revealed the slow growth of these fish. Several subsequent fish surveys and experimental techniques have been in an attempt to determine the cause or causes of the slow growth. Unfortunately, none of these attempts proved successful in determining cause or in improving bluegill growth. Therefore, in his 1995 IDNR report (Appendix G), Mr. Jed Pearson recommends that "it may be better to abandon any effort to improve bluegil fishing and concentrate greater effort toward providing fishing opportunities for alternative species". I concur with Mr. Pearson's recommendation. Species such as smallmouth bass and walleye have been shown to be popular with anglers and could be stocked thus providing more opportunities for an enjoyable fishing experience.

Having concurred with Mr. Pearson, I also recognize that local anglers and lake residents might still wish to have additional studies performed. One possible study would be to determine what food items are consumed by bluegills of various age/size classes. Adult bluegills have been found to feed predominantly on zooplankton (Osenberg, Mittelbach and Wainwright, 1992). Feeding by bluegills occurs predominantly on *Daphnia* in deeper water limnetic zones in July and August and it is ingestion of these optimal prey that leads to rapid size increases in bluegills (Mittelbach, 1981). Data for population sizes and species diversity of *Daphnia* (as well as that for other zooplankton) in both littoral and limnetic communities would be very informative for Upper Long Lake. Slow growth of bluegills could be a direct reflection on depauperate populations of zooplankton. However, funding for such a project might be difficult to obtain. The IDNR probably would not be interested in providing funding based on Mr. Pearson's recommendation to abandon efforts to improve bluegill stocking. Therefore, the prospects for improving the bluegill fishing in Upper Long Lake appear dim.

WATER QUALITY AND SEDIMENT MANAGEMENT

The water quality in Upper Long Lake remains good and has changed little over the last two decades. In-lake activities do not play a major role in nutrient input to the lake whereas runoff from the watershed does supply the nutrients and other substances which can influence water quality. The primary recommendations for maintaining the water quality are those dealing with the watershed. These recommendations have been put forth by Mr. Gensic in the first part of this report and I will not reiterate them. If these recommendations are implemented they will help to maintain the good water quality in Upper Long Lake.

The same recommendations hold for managing sediment. Current nutrient levels in the sediment appear to be low. If nutrient input from the watershed is controlled, the sediment will not gain excess nutrients beyond what results from normal decomposition processes. However, if significant dredging occurs, then nutrients can be released from the sediments and put into the water column providing the potential for localized algal blooms. Therefore, it is recommended that dredging be done only when necessary to avoid adding excess nutrients to the water column.

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APPENDIX A

STREAM SAMPLE LABORATORY RESULTS

EDGLO LABORATORIES, INC. CHAIN OF CUSTODY

Project Name: UPPER LONG LAKE FEASIBILITY STUDY

Samplers (Signature): Michael

Date	Time	Cmp	Grb	Sample Location	No. Cont.	Unp	HNO3	H2SO4	NaOH	ZnOa	HCL	Vials
6-7-93	5:15PM		✓	1 SUNSET SHORES	2	X		X				
6-7-93	5:40P.M		✓	(KIRKPATRICK BRANCH SUBWATERSHED) MAW NORTEZ 2 DITCH	2	X		X				
6-7-93	6:10P.M		✓	3 KUHN TILE	2	X		X				
6-7-93	6:35PM		✓	4 KOHN TILE	2	X		X				
6-7-93	6:45P.M		✓	5 COHEE TILE	2	X		X				
6-7-93	7:20 P.M		✓	6 PLEASANT LAKE DITCH @ 25N	2	X		X				

RECEIVED JUN 11 1993

Relinquished by: (Signature) (Date, Time)	Received by: (Signature) (Date, Time)
Michael [signature] 6-8-93 8:10 A.M	[signature] 6/8 8:10am

Relinquished by: (Signature) (Date, Time)	Received by: (Signature) (Date, Time)

Remarks:

TSS / Phos / ~~T~~TKN

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311 Airport N. Office Pk.
Ft. Wayne, IN 46825

Attn: Michael Gensic

SAMPLE MATRIX:	Water
SAMPLE TYPE:	001 Sample - 06/07/93
LAB REPORT NO.	001
LOG SHEET NO.	0693-306
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
#1 Sunset Shores						
T.Sus.Solids	755.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.20	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	9.0	MG/L		06/17/93		BB

< = LESS THAN

RESPECTFULLY SUBMITTED BY:

Ed [signature]

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SAMPLE MATRIX:	Water
SAMPLE TYPE:	002 Sample - 06/07/93
LAB REPORT NO.	002
LOG SHEET NO.	0693-307
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
#2 Maw Hortz Ditch-06/07/93-5:40pm (KIRKPATRICK BRANCH SUBWATERSHED)						
T.Sus.Solids	1,088.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.61	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	8.0	MG/L		06/17/93		BB

< = LESS THAN

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SAMPLE MATRIX:	Water
SAMPLE TYPE:	003 Sample - 06/07/93
LAB REPORT NO.	003
LOG SHEET NO.	0693-308
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
#3 Kuhn Tile-06/07/93-6:10pm						
T.Sus.Solids	106.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.27	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	1.0	MG/L		06/17/93		BB

< = LESS THAN

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Ed Gunston

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SAMPLE MATRIX:	Water
SAMPLE TYPE:	004 Sample - 06/07/93
LAB REPORT NO.	004
LOG SHEET NO.	0693-309
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
#4 Kohn Tile-06/07/93-6:35pm						
T.Sus.Solids	2,710.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.81	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	11.0	MG/L		06/17/93		BB

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Ed Guenther

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Attn: Michael Gensic

SAMPLE MATRIX:	Water
SAMPLE TYPE:	005 Sample - 06/07/93
LAB REPORT NO.	005
LOG SHEET NO.	0693-310
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
#5 ~~Coffee~~ Cohee Tile-06/07/93-6:45pm						
T.Sus.Solids	73.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.31	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	4.0	MG/L		06/17/93		BB

< = LESS THAN

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Attn: Michael Gensic

SAMPLE MATRIX:	Water
SAMPLE TYPE:	006 Sample - 06/07/93
LAB REPORT NO.	006
LOG SHEET NO.	0693-311
DATE RECEIVED:	06/08/93
DATE REPORTED:	06/22/93

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY DATE	ANALYSIS TIME	ANALYST
#6 Pleasant Lk. Ditch @-06/07/93-6:35pm						
T.Sus.Solids	635.0	MG/L	EPA 160.2	06/09/93	1:00pm	JG
Phosphorus	0.17	MG/L	EPA 365.1	06/09/93	3:45pm	PR
TKN*	5.0	MG/L		06/17/93		BB

< = LESS THAN

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EDGLO LABORATORIES, INC.

SAMPLE CHAIN OF CUSTODY FORM

CLIENT/COMPANY NAME	PROJECT/SITE NAME
Censic & Associates	Upper Long Lake
SAMPLERS (SIGNATURE)	**REMARKS**
Michael Senecin	

COLLECTION TIME	COLLECTION DATE	SAMPLE LOCATION DESCRIPTION	PRES. CODE	Sample Type GRB.	Sample Type CMP.	TSS	T. PHOS.	TKN
5:00PM ~~3:2~~	3-25-96	Mawhorter Ditch (Kirk.) #1 } (Kirkpatrick Branch Subwatershed)				✓	✓	✓
5:00 PM	3-25-96	Mawhorter Ditch (Kirk.) #2				✓	✓	✓
5:30PM	3-25-96	Pleasant Lake Ditch @ 25 N #3				✓	✓	✓
5:30PM	3-25-96	Pleasant Lake Ditch @ 25 N #4				✓	✓	✓

RECEIVED

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)
Peter ...	3/26/96	8:30A	[signature]
RELINQUISHED BY (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY (SIGNATURE)**

SPECIAL INSTRUCTIONS:

PRESERVATIVE CODES

UNP	=	UNPRESERVED
HNO3	=	NITRIC ACID
H2S04	=	SULFURIC ACID
NaOH	=	SODIUM HYDROXIDE
HCl	=	HYDROCHLORIC ACID
ZnOAc	=	ZINC ACETATE

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MR. MICHAEL GENSIC
GENSIC & ASSOCIATES
311 AIRPORT N. OFFICE PARK
FORT WAYNE, IN 46825

Upper Long Lake

SAMPLE MATRIX: Water 03/25/96-5:30pm
SAMPLE TYPE: Pleasant Lake Ditch @ 25 North#3,4
LAB REPORT NO. 008
LOG SHEET NO. 03961220
DATE RECEIVED: 03/26/96-8:30am
DATE REPORTED: 04/04/96

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
T. Sus. Solids	< 5.0	MG/L	EPA 160.2	04/01/96	1:00pm	PFR
Phosphorus	< 0.10	MG/L	EPA 365.1	03/28/96	11:00am	PFR
T. Kjeldahl Nitrogen	9.0	MG/L	EPA 351.3	04/03/96		BB

< = LESS THAN

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MR. MICHAEL GENSIC
GENSIC & ASSOCIATES
311 AIRPORT N. OFFICE PARK
FORT WAYNE, IN 46825

SAMPLE MATRIX: Water Upper Long Lake
SAMPLE TYPE: Mawhorter Ditch #1,#2-03/25/96-5pm
LAB REPORT NO. 007
LOG SHEET NO. 03961219
DATE RECEIVED: 03/26/96-8:30am
DATE REPORTED: 04/04/96

PARAMETER	RESULT	UNITS	METHOD CODE	LABORATORY ANALYSIS DATE	TIME	ANALYST
T. Sus. Solids	< 5.0	MG/L	EPA 160.2	04/01/96	1:00pm	PFR
Phosphorus	< 0.10	MG/L	EPA 365.1	03/28/96	11:00am	PFR
T. Kjeldahl Nitrogen	3.0	MG/L	EPA 351.3	04/03/96		BB

(KIRKPATRICK BRANCH SUBWATERSHED)

< = LESS THAN

RESPECTFULLY SUBMITTED BY:

APPENDIX B

INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF NATURE PRESERVES
CORRESPONDENCE

INDIANA DEPARTMENT OF NATURAL RESOURCES

PATRICK R. RALSTON, DIRECTOR

Division of Nature Preserves
402 W. Washington St., Rm. 267
Indianapolis, Indiana 46204
317-232-4052

March 28, 1996

Mr. Mike Gensic
Gensic & Associates
311 Airport North Office Park
Fort Wayne, IN 46825

Dear Mr. Gensic:

I am responding to your request for information on the endangered, threatened, or rare (ETR) species, high quality natural communities, and natural areas documented from the Upper Long Lake Watershed. The Indiana Natural Heritage Data Center has been checked and there were no ETR species nor significant areas documented from the site.

The information I am providing does not preclude the requirement for further consultation with the U.S. Fish and Wildlife Service as required under Section 7 of the Endangered Species Act of 1973. You should contact the Service at their Bloomington, Indiana office.

U.S. Fish and Wildlife Service
620 South Walker St.
Bloomington, Indiana 47403-2121
(812)334-4261

At some point, you may need to contact the Department of Natural Resources' Environmental Review Coordinator so that other divisions within the department have the opportunity to review your proposal. For more information, please contact:

Patrick R. Ralston, Director
Department of Natural Resources
attn: Stephen H. Jose
Environmental Coordinator
Division of Fish and Wildlife
402 W. Washington Street, Room W273
Indianapolis, IN 46204
(317)232-4080

Please note that the Indiana Natural Heritage Data Center relies on the observations of many individuals for our data. In most cases, the information is not the result of comprehensive field surveys conducted at particular sites. Therefore, our statement that there are no documented significant natural features at a site should not be interpreted to mean that the site does not support special plants or animals.

Due to the dynamic nature and sensitivity of the data, this information should not be used for any project other than that for which it was originally intended. It may be necessary for you to request updated material from us in order to base your planning decisions on the most current information.

Thank you for contacting the Indiana Natural Heritage Data Center. You may reach me at (317)232-4052 if you have any questions or need additional information.

Sincerely,

Ronald P. Hellmich

Ronald P. Hellmich
Indiana Natural Heritage Data Center

APPENDIX C

LAND MANAGEMENT PRACTICES

LAKE & RIVER ENHANCEMENT
Watershed Land Treatment
Cost-Shared Practices

November 1996

At the State Soil Conservation Board's (SSCB) request, the LARE staff appraised the conservation practices eligible for cost-sharing and incentive assistance in watershed land treatment project areas. This was done in order to evaluate the practices' viability and appropriateness in fulfilling LARE program goals. The staff also considered whether there were additional practices that might be added to the eligibility list. At regularly scheduled public meetings the SSCB then adopted the following as cost-sharable practices.

It is important to understand that implementation of any of the practices is predicated on the compilation of a whole farm inventory and development of a complete resource management system (RMS) plan for any farm that is to receive cost-share funds.

Conservation Tillage: Original policy allowed for cost-sharing on *no till* and *mulch till*, both of which leave crop residue on the surface to provide protective cover over the soil, preventing sheet and rill erosion. Farmers in some areas of the state have been more receptive to the practices than others, and producers are more apt to no till soybeans than corn. It may be discovered that cost-sharing alone will not be sufficient incentive to initiate no tilling for corn production. As research and experience with the practices continue to expand, it is hoped that their adoption will increase. However, since there is still a reluctance by many farmers to reduce tillage to levels necessary to effectively control erosion, cost-sharing shall be continued at the 80%/65% rate on a maximum of $15/acre total cost for no till and $8/acre total cost for mulch till. In watershed land treatment project areas, some form of conservation tillage shall be a prerequisite to cost-sharing on other practices, such as structures, which are also intended to control erosion. Cost-sharing for conservation tillage is not appropriate for landusers who already own the appropriate tillage equipment or have already adopted a conservation tillage system, and shall not be made available to any landuser for more than three years (based on a three-year whole farm plan).

Cover Crop: Erosion control can be enhanced with off-season cover crops on fields not having sufficient crop residue. A secondary benefit is that commercial nitrogen fertilizer usage can be reduced since leguminous cover crops add nitrogen to the soil and non-leguminous cover crops can return nitrogen to the soil as they decompose. Acceptance of the practice has varied in watershed project areas. Some producers have had experiences with cover crops that did not meet their expectations. However, new techniques for killing cover crops are making the practice more attractive, especially after production of silage and soybeans. As farmers become more familiar with the economic, environmental, and agronomic benefits of cover crops, it is anticipated that use of the practice will continue even after the cost-share period ends. Cost-sharing shall be continued at the current 80%/65% rate on a maximum total cost of $12/acre to help pay for seeding and killing the crop. Cost-sharing shall not be made available to any landuser for more than three years (based on a three-year whole farm plan).

Critical Area Planting: This practice provides for the planting of vegetation such as trees, shrubs, grass, or legumes on highly or critically eroding areas; it could also be applied to a problem such as a wet seep on a hillside, and could involve a buffer around a wetland. Erosion is generally reduced by protecting steep slopes or highly erodible soils. Cost-sharing assists with site preparation, seeding, and maintenance of the planting or stabilization. In most cases, small acreages in a larger field can be vegetated and protected, while the remainder of the field can still be farmed without suffering unacceptable erosion. Cost-sharing shall be continued at the current 80%/65% rate on a maximum total cost of $400/acre.

Diversion: In order to re-direct significant surface water flow which would otherwise contribute to erosion, a diversion channel (and downslope supporting ridge) can be constructed across the slope of a field to transport the water to a more stable area. It is determined that the 80%/65% cost-share rates shall be applied toward the engineer's estimate or the actual cost, whichever is less (with the anticipated actual cost to be approximately $3/linear foot).

Fencing: Fences can be beneficial when there is a need to exclude livestock from environmentally sensitive areas, to regulate livestock access to a particular area, or to permit proper grazing distribution in pastures, all of which lead to erosion control and/or water quality protection. The practice does *not* include any form of temporary fencing. Fencing adjacent to water bodies should be installed in conjunction with vegetated filter strips of appropriate recommended widths. The 80%/65% cost-share rates shall be applied toward the engineer's estimate or the actual cost, whichever is less (with the anticipated actual cost to be approximately $1.50/linear foot).

Field Windbreak: A strip/row of trees or shrubs in or adjacent to a field can reduce wind erosion effects, shield crops and enhance their growth, and create wildlife habitat. Although not as directly beneficial to surface water quality as many other practices, a windbreak can constrain wind-blown soil that might be washed into roadside ditches or otherwise enter streams or lakes. Professional assistance regarding species selection and planting regimes can be solicited from IDNR district foresters, and is encouraged. The 80%/65% cost-share rates shall be applied toward the engineer's estimate or the actual cost, whichever is less (with the anticipated actual cost to be approximately $400/acre).

Filter Strip: A vegetated buffer can trap eroded soil and stormwater-borne nutrients and pesticides which might otherwise be transported downslope into surface waters. This practice can be extremely beneficial in affording protection where other measures may not be practicable. Filter strips can also supplement practices which may not, themselves, be fully satisfactory for protecting water bodies from agricultural pollutants. For example, even though conservation tillage can reduce erosion on a crop field, a certain amount of soil can still be eroded from the field -- but could be trapped by a filter strip. The effectiveness of filter strips is influenced by factors such as width, slope, vegetation type, sediment particle size, and runoff rate. Areas taken out of production to create filter strips can be used for access to a field, haying, or to provide a safety buffer to prevent tractor accidents along ditches and streams. This is a highly desirable practice which is strongly encouraged, but is difficult to convince many farmers to adopt since it results in reduced field size. Cost-share assists with the preparation of the site, seeding, and sufficient maintenance to assure successful initial development. Actual installation costs are variable, but in the proximity of $100/acre for grass establishment. Additional ecological and water quality benefits can be provided if shrubs and/or trees are strategically incorporated into the riparian buffer area. To simplify previous policy, it is determined that a flat rate of $650/acre shall be paid to cover installation costs plus provide an economic incentive to the landowner. Filter strips are intended to be relatively narrow bands of vegetation, adjacent to water bodies, which will remove pollutants that might otherwise enter the water, and provide ecological benefits. They are not intended for large scale applications covering entire fields. Appropriate widths shall be based on slopes, per NRCS specifications; added width may be justified to allow for removal of nutrients and/or pesticides.

Grade Stabilization Structure: In areas where the concentration and flow velocity of runoff is sufficiently high, an engineered structure such as a rock chute or block chute is required to control the grade and head-cutting of natural or artificial channels, thereby preventing the advancement or formation of gullies. As with certain other practices, installation of these structures can result in a directed discharge of waterborne pollutants into receiving streams. For this reason, their construction should be accompanied by installation of appropriately designed filter strips which can trap sediment, nutrients, and pesticides upstream from the structure. These filter strips must be sized to allow for conformance with regulations pertaining to application setbacks for specific pesticides used in their vicinity. The 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less, with a maximum total cost to be no greater than $6,000.

Grassed Waterway: Grassy vegetation in an area of concentrated flow can greatly reduce erosion. A grassed waterway is typically a constructed shallow channel that is shaped and vegetated to provide for stable conveyance of runoff. The practice is not appropriate where its construction would destroy significant woody vegetation, and where the present watercourse is not seriously degraded and is capable of conveying existing flows. If the design dictates use of a tile beneath the waterway, consideration must be given to installation of an appropriately sized grass buffer which will remove waterborne pollutants prior to the water's entry through the tile inlet. (Refer to "Tile Riser Grassed Buffer" practice description.) The 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less, with an anticipated approximate maximum cost to be $4/linear foot.

Livestock Watering Facility: A trough or tank can be strategically located to provide an acceptable water supply for livestock. This practice is applicable in situations where it is desirable to provide an alternative water source and prevent livestock from entering lakes or streams. This reduces the animals' detrimental impacts on water quality. Installations often require use of crushed stone to provide a suitable base for the tank and, in the case of *spring developments*, require some PVC piping to direct water to the container. Typically, it is appropriate to apply vegetative cover as a complement to the watering trough installation in order to reduce erosion at the site. Cost-share does not apply to any pumps or electrical connections. It is determined that the 80%/65% rates shall be applied toward the estimated or actual cost of the installation, whichever is less, with an anticipated maximum cost of $1,200.

Nutrient Management: Managing the amount, form, placement, and timing of application of plant nutrients is not only a significant economic concern, it is also an important water quality consideration. This practice applies to the management of organic wastes (manure), commercial fertilizers, legume crops, and crop residues. The purpose is to optimize usage of plant nutrients for forage and crop yields, while minimizing their introduction into surface and ground waters, protecting air quality, and maintaining or improving the chemical and biological condition of the soil. Cost-sharing shall be continued for soil samples that the cooperator has analyzed, and upon which nutrient applications are based. However, this practice shall be combined with the Pest Management practice and they shall be collectively referred to as *Integrated Crop Management* with a single maximum rate of $8/acre for the combination. Cost-share payment shall be at the 80%/65% rate. Cost-sharing shall not be made available to any landuser for more than three years (based on a three-year whole farm plan).

Pasture and Hayland Planting: It can be beneficial to establish or re-establish long-term stands of adapted species of perennial, biennial, or reseeding forage plants in order to reduce erosion on existing low quality pasture/hayland or to transform heavily eroding land to a more productive use. The landuser can not only benefit economically, but erosion which impairs surface water quality is reduced as well. It is determined that the 80%/65% cost-sharing rates shall be applied toward the estimated or actual cost of the installation, whichever is less, and would include seeding, fertilization, and initial maintenance, in accordance with NRCS specifications. The Field Office Technical Guide states that, *for erosion control* (which is the intent of this practice), a grass-legume mixture should be selected, rather than a single variety stand such as alfalfa. Alfalfa not only is more expensive, it is not suitable by itself for erosion control and is not eligible for cost-sharing. The anticipated approximate maximum cost should be no more than $150/acre, but can vary considerably, depending on site conditions.

Pest Management: Managing agricultural pest infestations(including weeds, insects, and diseases) is critical to producers' financial success. It is essential that adverse effects to plant growth and crop production be reduced, but the use of pesticides can have negative environmental consequences. It is therefore beneficial to water quality goals to minimize chemical usage through application of an integrated approach to pest control.

This generally involves appropriate chemical usage, but also includes enhanced recordkeeping, scouting, and other forms of non-chemical pest management. This can result in a reduction of chemical introduction into surface and ground waters. It is determined that cost-sharing of this practice shall be continued, but as a component of a new *Integrated Crop Management* practice that includes Nutrient Management. The 80%/65% rates should be applied to a maximum flat-rate of $8/acre for the combination ICM practice. Cost-sharing shall not be made available to any landuser for more than three years (based on a three-year whole farm plan).

__Sediment (Control) Basin__: In some locations it is not practicable to fully control the source of erosion, so some measure is required to constrain the eroded soil. A sediment basin can be constructed which will help preserve reservoirs, ditches, canals, diversions, waterways, streams, and lakes. Such a basin can trap waterborne sediment originating from areas where physical conditions or land ownership preclude treatment of the problem source. Sediment basins are not intended to be recreational ponds, but consideration will be given to hybrid structures that may incorporate constructed wetland characteristics. The practice shall be accompanied by the installation of an appropriate upstream grass buffer zone (based on site-specific design considerations) which will reduce the introduction of nutrients and/or pesticides. The impoundment structure (dam) shall be vegetated to control its erosion. In situations requiring future periodic or occasional maintenance, it is essential that measures be implemented to provide adequate access for maintenance equipment. The 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less (with the anticipated actual cost to be approximately $1.50/cubic yard of storage capacity).

__Streambank Protection__: Vegetation and/or structures can be effectively used to stabilize and protect the banks of streams or channels from scour and erosion. This reduces sediment loads that cause downstream damages and pollution, and can also improve the stream for recreation and as habitat for fish and wildlife. Regional IDNR biologists and foresters possess knowledge that may be useful in evaluating project sites and developing appropriate plans, so their inclusion in the planning process is encouraged. This practice applies where streambanks are susceptible to erosion from the action of water or ice, or to damage from livestock. If the affected stream is a "regulated drain" subject to county jurisdiction, it is essential that any project be approved during the planning stage by the county drainage board. Some projects may require regulatory permits from IDNR or the Corps of Engineers, which should be ascertained prior to construction. The 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less. The anticipated maximum costs would be as follows:

Riprap	$25.00 per linear foot
Vegetation	$ 2.50 per linear foot
Combination	$ 7.50 per linear foot

__Terrace (Gradient and Parallel)__: An earthen embankment, ridge, or channel constructed across a slope can reduce erosion by intercepting and conducting surface runoff at a nonerosive velocity to a stabilized outlet. These structures can allow otherwise erodible slopes to be cropped. However, it has been determined that their outlets can also serve as direct conduits for pesticides and nutrients transported by the runoff they convey to streams and lakes. It is therefore required that any terrace construction be accompanied by appropriate installation of grassed buffer zones to remove pollutants that would otherwise be directed through tiles into streams or lakes. Cost-share assistance shall be provided for terraces only on a limited basis when erosion is severe and other measures are not practicable. In those cases, tile inlets should be protected by appropriate buffer zones and the outlets should discharge over/through additional appropriately designed grassed buffers or wetlands before discharging into streams or lakes. (Refer to "Tile Riser Grassed Buffer" and "Watercourse Outlet Buffer" practice descriptions.) The 80%/65% rates should be applied toward the engineer's estimate or the actual cost, whichever is less (with an anticipated approximate maximum cost of $2/linear foot).

Tree Planting: Establishing a stand of trees can control erosion, conserve soil, and retain moisture. This can aid in flood reduction, sedimentation control, and wildlife habitat improvement. Water quality benefits can be derived from plantings adjacent to streams which provide shade and act as a food source, and reduce streambank erosion. Mature trees can also serve as barriers to erosion-causing winds. Professional assistance regarding species selection and planting regimes can be solicited from IDNR district foresters, and is encouraged. This highly desirable practice should be encouraged and it is determined that the 80%/65% rates shall be applied toward the estimated or actual cost, whichever is less (with an anticipated maximum of $350/acre).

Waste Management System and Waste Utilization: Livestock waste must be properly managed, from both economic and environmental perspectives. A planned management system is a means of assuring proper storage and/or usage of the manure. A well designed system prevents or minimizes degradation of air, soil, and water resources and protects public health and safety. Systems prevent discharge of pollutants to surface or ground water and allow the waste to be recycled through soil and plants. A waste management system allows for more effective utilization of animal waste and minimizes nutrient and bacteria levels in runoff from barnyards and feedlots. An appropriately sized storage lagoon or waste pit allows producers to spread and incorporate the manure when conditions are ideal, e.g., during peak crop nutrient demand periods, thus reducing commercial fertilizer costs. This also reduces wear on transfer equipment that would otherwise be in continuous operation. A proper system must include an environmentally acceptable strategy for utilizing the waste, which is a prerequisite to cost-sharing on construction of a containment facility. Manure *dry stacking* facilities are another method for handling waste and are also eligible for cost-sharing. It is determined that the 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less, of the design and/or construction of waste containment facilities, with a maximum total cost of $20,000. In addition, the 80%/65% rates shall be applied toward the estimated or actual cost of *waste utilization* (with the anticipated maximum being $0.01/gallon). Cost-share funds for waste management are only to be made available to resolve existing livestock waste problems. Funds will not be made available for expansion of a facility to accommodate additional animals, or for new facilities.

Water and Sediment Control Basin (WASCOB): Low earthen embankments or ridges can be constructed across slopes or minor watercourses to form sediment traps/water detention basins. They allow otherwise erodible areas to be stabilized so that they can still be cropped. A WASCOB can provide sufficient detention to trap larger soil particles, but may not remove smaller silt and clay particles from water that is discharged through the outlet tile. It has been determined that the outlets can serve as direct conduits for pesticides and nutrients transported by the runoff they convey to streams and lakes. It is therefore required that any WASCOB construction be accompanied by appropriate installation of grassed buffer areas to remove pollutants that would otherwise be directed through tiles into streams or lakes. (Refer to "Tile Riser Grassed Buffer" and "Watercourse Outlet Buffer" practice descriptions.) WASCOBs can be appropriate in settings where the terrain is too steep for grassed waterways, but are not to be considered as a means to allow overly steep slopes to be cropped; such crop fields would best be converted to other uses. It is recommended that cost-share assistance be provided for WASCOBs only on a limited basis when erosion is severe and other measures are not practicable. In those cases, tile inlets shall be protected by appropriate buffers and the outlets should discharge over/through additional appropriately designed filter strips or through constructed or existing wetlands before discharging into streams or lakes. The 80%/65% rates should be applied toward the engineer's estimate or the actual cost, whichever is less (with an anticipated approximate maximum cost of $1,500/basin).

Wetland Development or Improvement: Wetlands have many beneficial attributes including 1) supporting forest, fish, and wildlife resources; 2) retaining and gradually releasing floodwater; 3) recharging ground water; 4) reducing the impacts of eroded soil and nutrients on the ecology of lakes and streams; 5) providing areas for recreation; and 6) sustaining rare and endangered organisms. Approximately 85% of Indiana's original wetlands have been drained or filled, so it has become increasingly more important to protect and/or restore wetlands whenever possible. This practice provides for the creation of an artificial wetland or the restoration of a previously drained wetland by constructing a dike or dam, filling a surface drain, or removing a subsurface drain. It is determined that the 80%/65% rates shall be applied toward the engineer's estimate or the actual cost, whichever is less (with an anticipated approximate maximum cost of $400/acre).

NEW PRACTICES

Tile Riser Grassed Buffers: Certain practices such as grassed waterways, WASCOBs, and terraces (as well as flat, tiled land), which have tile riser inlets can pose a pollution threat to the streams or lakes into which they discharge runoff. Water that flows into the structures needs to be treated in some way to allow removal of eroded soil, nutrients, and pesticides. Research has shown that grassed buffers can provide such treatment. Therefore. it is determined that appropriate buffers shall be required for all new structures with tile inlets. Installation of buffers is encouraged on existing structures (and tile systems) and cost-share funds are also available for the retrofitting. In order to be consistent with current federal herbicide application requirements, a 66-foot diameter (minimum) grassed buffer area shall be installed around tile inlets. For WASCOBs, seeding is required 66 feet upstream of and to the sides of the riser, but only up to the top of the ridge (on the ridge's upstream side). A cost-share flat rate of $250 is established for each site.

Blind Tile Inlet: As an alternative to open tile inlets (risers) on grassed waterways and for field drainage, cost-share funding is available for blind inlets (french drains) which will prevent some of the pollutant problems. The inlets may be replaced with coarse crushed stone which offers some limited filtration to inflowing water, and the stone would then be surrounded by a grassed buffer area. The stone partially impedes water flow, so that during heavy rains much of the runoff would actually flow over the stone rather than into the inlet. A cost-share flat rate of $350 is established for each site.

Watercourse Outlet Buffers: Concentrated stormwater runoff which is flowing from a field can cause significant erosion where it enters a ditch or stream. The problem can be mitigated with vegetation and/or different types of grade stabilization structures. The runoff can also transport nutrients and/or pesticides washed from soil and plants. In order to reduce the impact of the pollutants, cost-share funds are available for installation of grassed buffers as "stand-alone" features, or to supplement structural measures. Funding is allowed for seeding a 66-foot radius semicircular area upgradient from and prior to the point of entry into the ditch/stream. Any existing well vegetated or wooded areas shall not be destroyed to accommodate installation of the grassed buffer. A cost-share flat rate of $125 is available for each site, whether to enhance existing conditions, or as part of construction of a new measure such as a grade stabilization structure.

IDNR LAKE & RIVER ENHANCEMENT
WATERSHED LAND TREATMENT PROJECTS

COST SHARE FOR APPROVED WLTP PRACTICES

If a practice is applied within one mile of a project-targeted lake, or within one-half mile of a perennial stream in the project watershed, the maximum cost share is 80% of the practice's cost.
If a practice is applied further than one mile away from a project-targeted lake, or more than one-half mile from a perennial stream in the project watershed, the maximum cost share is 65% of the practice's cost.

THE FOLLOWING PRACTICES WILL BE COST SHARED BASED ON THE IDENTIFIED MAXIMUM ESTABLISHED RATES.

For example: If a landowner plants cover crops on one acre of land, the maximum cost is $12.00 per acre. He/she will be paid either 80% of $12.00 ($9.60) or 65% of $12.00 (7.80) depending on the site's proximity to the project-targeted water body.

PRACTICE	MAXIMUM ALLOWABLE COST
Conservation tillage	
No-till	$15.00 per acre (Maximum 3 years)
Mulch till	$ 8.00 per acre (Maximum 3 years)
Cover crops	$12.00 per acre (Maximum 3 years)
Critical area planting	$400.00 per acre
Integrated Crop Management	$8.00 per acre (Maximum 3 years)

PRACTICE	Flat Rate
Tile Riser Grassed Buffer	$250.00 each
Blind tile inlet	$350.00 each
Watercourse outlets Buffer	$125.00 each
Filter strip Appropriate widths would be based on topography (slopes) per NRCS specifications.	$650.00 per acre

THE FOLLOWING PRACTICES WILL BE COST-SHARED BASED ON THE ACTUAL COST OF INSTALLATION, OR THE FINAL WRITTEN ENGINEERING ESTIMATE, WHICHEVER IS LESS.

For example: If a landowner installs a grassed waterway for which the contractor charges $4.25 / lineal foot, but the engineer's estimate is $4.00/ lineal foot, the landowner will be paid either 80% of $4.00/foot ($3.20) or 65% of $4.00/foot ($2.60), depending on the sites proximity to the project- targeted water body.

PRACTICE	ESTIMATED UNIT COST (For planning Purposes)
Diversion	$3.00 per foot
Fencing	$1.50 per foot
Field windbreak	$400.00 per acre
Grade Stabilization Structure	$6,000.00 Based on site Specific Estimate
Grassed Waterway	$4.00 per foot
Livestock watering facility	$1,200.00 per facility
Pasture and hayland planting	$150.00 per acre
Sediment Basin	$1.50 cubic yard
Streambank protection	
rock riprap	$25.00 per linear foot
vegetative	$2.50 per linear foot
combination	$7.50 per linear foot
Terrace	$2.00 per linear foot
Tree planting	$350.00 per acre
Waste management system	
containment system	$20,000.00 per facility
waste utilization	$0.01 per gallon
Water and sediment control basin	$1,500.00 per basin
Wetland development & improvement	$400.00 per acre

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ► 5

To Wayne Stanger	From Bev Stevenson
Dept./Agency NRCS	Phone # 219-533-3630
Fax # 219-636-2556	Fax # 219-533-6969

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

TO: INDIANA STATE FSA OFFICE
CONSERVATION DIVISION
INDIANA STATE NRCS OFFICE
PROGRAM DIVISION

FROM: St. Joseph and Tippecanoe Conservation Priority Area Work Group

SUBMITTED BY: Bev Stevenson ~~and Sam St. Clair~~, Designated Conservationists

SUBJECT: St. Joseph and Tippecanoe EQIP Ranking Process

Attached you will find a copy of the proposed ranking criteria for EQIP 1997 applications in the St. Joseph and Tippecanoe Conservation Priority Area. There is also a list of the proposed practices and flat rate cost as well as incentive payments associated with them.

GENERAL REQUIREMENTS FOR EQIP PROPOSALS

All resource concerns which have been identified for the priority area must be addressed in the conservation plan. All practices needed to address the identified resource concerns must be already applied and maintained or included in the EQIP contract.

Proposals not meeting "T" for all cropland will receive 0 points under section 1A.

The significant critical soils are defined as: the most erosive soil type which constitutes at least 15% of the field.

For purposes of the EQIP application, a nutrient and/or pesticide or grazing management plan which a producer develops with his or her fertilizer/chemical dealer, consultant or scouting service (who is a certified crop advisor) and meets Indiana State Chemist guidelines constitutes an acceptable plan. The producer would just need to provide verification in the form of some signed statement from the dealer that the plan is in place and can be spot checked if needed.

ST. JOSEPH AND TIPPECANOE CONSERVATION PRIORITY AREA
PROPOSED PRACTICES AND PAYMENT RATES

Cost Share Practices (practices pertaining to direct over-land flow to any waterbody will receive 75% c/s. All others, will receive 50% c/s.)

Practice	FOTG#	Cost Limitations
Waterway	412	
WASCOB's	638	
Pasture and Hayland Establishment (new only)	512	NTE $120/ac *
Grade Stabilization Structure	410	
Critical Area Plantings	342	
Livestock Watering Facility	574	
Diversion	362	
Streambank Stabilization	584	
Fencing	382	
Field Borders	386	
Tree Planting (conversion of potentially croppable areas)	612	NTE $221/ac
Sediment Retention Ponds	350	
Wetland Establishment	657	
Composting	317	
Animal Waste Facility	312	
Wetlands as a secondary waste treatment	657	
Well Capping and Sealing	003	
Filter Strip	393	
Field Windbreak	392	
Riparian Forest Buffer	391	

* Must be increase in original acreage and have at least a 5 year cropping history. As needed as per RMS.

INCENTIVE PAYMENT PRACTICES

Practice	FOTG#	Incentive Payment
No-till (Producer nas not received c/s in the past and does not currently own the equipment)	329	$15/ac
Nutrient and/or Pesticide Management (recordkeeping)	590	$10/ac covered by the plan

Animal Waste Management	312	$10/ac covered by the plan
Cover Crops	340	$8/ac
Tile Riser Buffer		$250 ea.
Watercourse Outlet Buffer		$125 ea.
Blind Tile Inlet		$350 ea.

Other eligible practices include those listed in the Field Office Technical Guide (FOTG) and necessary to address the identified resource concerns.

APPENDIX D

WETLANDS AND WATER QUALITY

Water Quality

Wetlands and Water Quality

Brian K. Miller, Department of Forestry and Natural Resources

Wetlands once made up 25 percent of Indiana. Many of these 5.6 million acres were located in the fertile farmground of northern Indiana. Early in the 19th century, landowners began using open ditches and tiles to drain large areas of wetlands. They then converted the drained soil to agricultural production. Since then, nearly 86 percent of Indiana's wetlands have been drained or filled.

Wetlands are areas characterized by saturated or nearly saturated soils most of the year. Wetlands serve a number of important environmental functions. Location, soil type and surface and ground water movement determine which of the following functions a particular wetland may serve.

Flood Water Retention

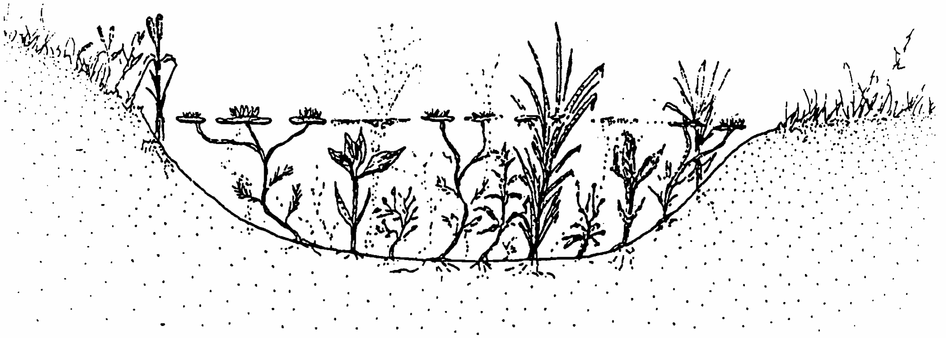
Usually located in depressions, wetlands receive surface runoff during storms. Water collects in these areas and contributes to stream flow when full or through ground water movement. Wetlands act as a holding area for large quantities of surface water which can be slowly released into a watershed. A one acre wetland, one foot deep, can hold approximately 330,000 gallons of water. When wetlands are removed, storm water runs directly into the watershed, increasing flooding.

Nutrient and Sediment Filtering

Often found in areas of intense agricultural production, wetlands play an important role in maintaining local water quality. Wetlands preserve water quality by removing nitrogen, phosphorus and pesticides from agricultural runoff.

Table 1. Common Wetland Aquatic Plants

Emergent	*Submergent*	*Floating*
Cattail	Pondweed	Duckweed
Spikerush	Naid	Watermeal
Smartweed	Watermilfoil	Water Hyacinth
Knotweed	Bladderwort	Water Lily
Arrowhead	Hydrilla	
Pickerelweed	Elodea	
	Coontail	



Chemicals and nutrients can enter a wetland through surface water and sediment, or through ground water. The major inorganic nutrients entering wetlands are nitrogen and phosphorus. In the wetland, nitrogen and phosphorus are removed from the surface water and transferred to the sediment, wetland plants or atmosphere. Some agricultural pesticides used in the Midwest can also be carried to the wetland through surface runoff.

Nitrates are lost from upland sites primarily through subsurface drainage. In the wetland, nitrates are absorbed by plants or converted (through an anaerobic process called denitrification) to nitrogen gas and lost to the atmosphere. Nitrate-N is efficiently removed from wetland surface waters by aquatic plants.

Ammonium-N enters wetlands primarily through surface runoff. In the wetland, ammonia is absorbed by plants or converted to nitrogen gas through volatilization. Nitrification can also occur, changing ammonia into nitrites and nitrates. The nitrate form of nitrogen is more readily removed from surface water by wetland plants than the ammonium form.

Phosphorus, organic nitrogen and some metals (iron or aluminum) usually attach to sediment and are carried by runoff to the wetland. By holding water, a wetland allows sediment and large particles to settle on the wetland bottom. The root systems of wetland plants then absorb nutrients from the sediment. Much like phosphorus, some pesticides also bind to sediment materials. Surface runoff carries the sediment materials to the wetlands and deposits them on the wetland bottom.

A particular wetland's function may change seasonally. During the growing season, in the summer and early fall, emergent and submerged aquatic plants (Table 1) take up large quantities of nutrients from water and sediment. Algae and floating plants absorb nutrients from surface water. These plants essentially convert the wetland into a "nutrient sink" by taking nutrients from the water and sediment and retaining them as plant material. By taking up and holding nutrients during the summer, wetlands decrease the possibility of contamination downstream (Figure 1).

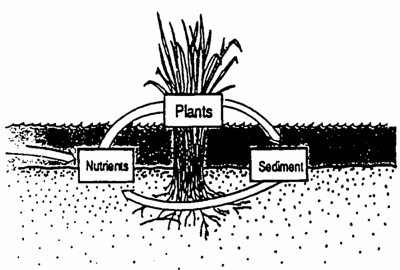


Figure 1. Sink

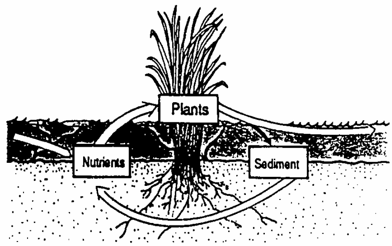


Figure 2. Source

When these plants die, a large portion of the nutrients return to the water and sediment from decaying plant material. During this period (in late fall and early spring), wetlands serve as a nutrient source when water flows from the wetlands to ecosystems downstream (Figure 2).

In most cases nutrients are recycled within the wetland. Emergent and submerged plants bring nutrients from the sediment into the water column, acting as "nutrients pumps." Algae and floating plants serve as "nutrient dumps" by taking nutrients from the water and depositing them back in the sediment when they die and settle on the bottom.

The cycle breaks when nutrients are removed from the wetland system, occurring when nutrient-rich water flows out of the wetland. The release of nitrogen gas to the atmosphere by denitrification, ammonia volatilization or possibly nitrification of ammonia also causes nutrients to be lost.

A wetland's natural filtering ability can become overloaded, disrupting the nutrient cycle. Steps can be taken to prevent overload by reducing nutrients and chemicals lost from agricultural fields.

Table 2. Benefits To Some Common Wildlife Species Provided By Wetland Vegetation

Type:	Plants around wetland edges	Emergent, submerged and floating vegetation in shallow water areas
Requirement:	Food and Cover	Food and Cover
	rabbits quail	waterfowl & broods
	pheasants song birds	muskrats mink otters fish insects
	waterfowl nest sites	song birds: red-winged blackbird,
		common yellow throat, marsh wren

Management practices to reduce runoff and leaching

The movement of nutrients and chemicals by sediment and surface runoff to wetlands can be reduced by conservation tillage and other common soil erosion control practices. These practices include: grass waterways, vegetative filterstrips, contouring and terracing. Incorporating fertilizers and chemicals reduces runoff by removing these substances from the runoff mixing zone.

Adjusting the timing and rate of fertilizer application to coincide with crop needs decreases nitrate leaching. Nitrate losses from animal waste can be reduced by timing of manure application, diverting feedlot runoff to grass filterstrips and limiting livestock's access to surface water.

Ground Water Exchange

Ground water and surface water are linked through wetlands. The following explains how wetlands impact surface water quality and also affect ground water quality and abundance.

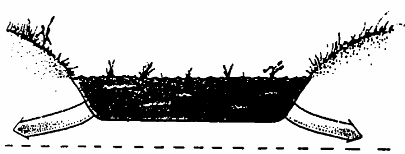


Figure 3. Water in wetlands, located above the water table, enters into ground water supplies if the underlying soils allow movement.

Wetlands with recharge capacity collect runoff water during storms and slowly release the water into ground water supplies (Figure 3). Wetlands therefore make positive contributions to soil moisture in agricultural settings. Without wetlands acting as a catch basin, damage from flooding and water erosion will likely increase.

In locations where the water table slopes away from the wetland, surface water in the wetland is relatively temporary. Because much of the volume may be contributed to recharge of ground water supplies. Draining these wetlands eliminates their recharge capacity and may adversely affect the surrounding soil moisture during dry periods.

Where the water table slopes toward the wetland, ground water discharges into the wetland (Figure 4). The water in this wetland is relatively permanent. Draining wetlands with ground water discharge capacity actually increases ground water discharge initially. However, over an extended period local water tables may be lowered.

Seasonal rainfall patterns may influence the direction of ground water flow within a wetland. During the spring, when water inputs are high, the wetland water level may be higher than the water table. At this time, the wetland acts as a point of recharge as water seeps from the wetland into the ground water. As the summer progresses, wetland water levels might drop to a level below the water table. Ground water then flows back into the wetland, which now serves as a point of ground water discharge (Figure 5).

Figure 4. Wetlands located lower than the water table can receive ground water discharge.

Wildlife Protection

The appearance, character and function of wetlands vary depending on the depth of the water, length of flooding and characteristics of the surrounding land. The different types of wetlands provide a unique array of habitats for many species of wildlife (Table 2).

Wetlands which do not contain standing water all year still provide valuable wildlife habitat. The vegetation growing around the wetland edge serves as food and cover for many wildlife species, particularly during migration.

As an example, many small aquatic invertebrates are produced during the wet spring period. They survive the dry months by going into a dormant stage. These invertebrates hatch the following spring when the wetland contains water. The hatching usually coincides with migratory waterfowl's northward journey.

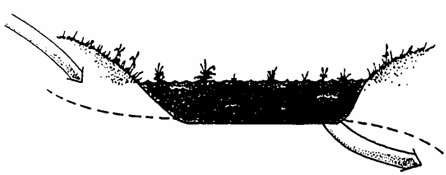


Figure 5. In many instances the same wetland may serve both functions. The water table slopes into a portion of the wetland and slopes away from the rest of the wetland. Where this "through flow" condition exists, wetlands are often referred to as semi-permanent.

Shallow water wetlands, which hold water throughout the year, contain emergent, submerged and floating vegetation throughout most of the marsh. The vegetation supports a variety of wildlife species (Table 2).

Submerged and emergent plants around the edges and shallow areas of deep water wetlands, provide food and cover for wildlife. In addition, the deep water area may furnish a suitable habitat for fish and often offers a source of recreation such as fishing, canoeing and swimming.

Preserving Wetlands

Wetlands play an important role in the freshwater system. They positively contribute to the quality of both surface and ground water supplies. In addition, wetlands provide habitat to many different species of wildlife.

In 1988, the U.S. Fish and Wildlife Service established a program in Indiana to assist landowners in restoring wetlands. For more information on the Wetland Restoration program contact: U.S. Fish and Wildlife Service, 718 N. Walnut Street, Bloomington, IN 47401, 812/334-4261.

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Editor: Cheri L. Janssen, Department of Agronomy

NEW 11/90 (5M)

Cooperative Extension work in Agriculture and Home Economics, state of Indiana, Purdue University, and U.S. Department of Agriculture cooperating; H. A. Wadsworth, Director, West Lafayette, IN. Issued in furtherance of the acts of May 8 and June 30, 1914. The Cooperative Extension Service of Purdue University is an affirmative action/equal opportunity institution.

APPENDIX E

AERIAL PHOTOGRAPH

APPENDIX F

FORMULA FOR LIGHT TRANSMISSIONS ESTIMATION

ESTIMATION OF LIGHT TRANSMISSION
USING SECCHI DISK TRANSPARENCY

When light transmission cannot be measured directly with a photocell, an estimation can be derived using the following equations:

$$L_{1\%} = 2.5 * SD \qquad \text{(eq. 1)}$$

$$\log L_{3'} = \frac{-2.4}{SD} \qquad \text{(eq. 2)}$$

where, $L_{1\%}$ is the depth (in feet) at which light transmission is one percent of the indicent light, and $L_{3'}$ is the light transmission at the three-foot depth.

EXAMPLE: Given SD = 4 ft.

$$L_{1\%} = 2.5 * 4 = 10 \text{ ft.}$$

$$\log L_{3'} = \frac{-2.4}{4} = 0.25 = 25\%$$

APPENDIX G

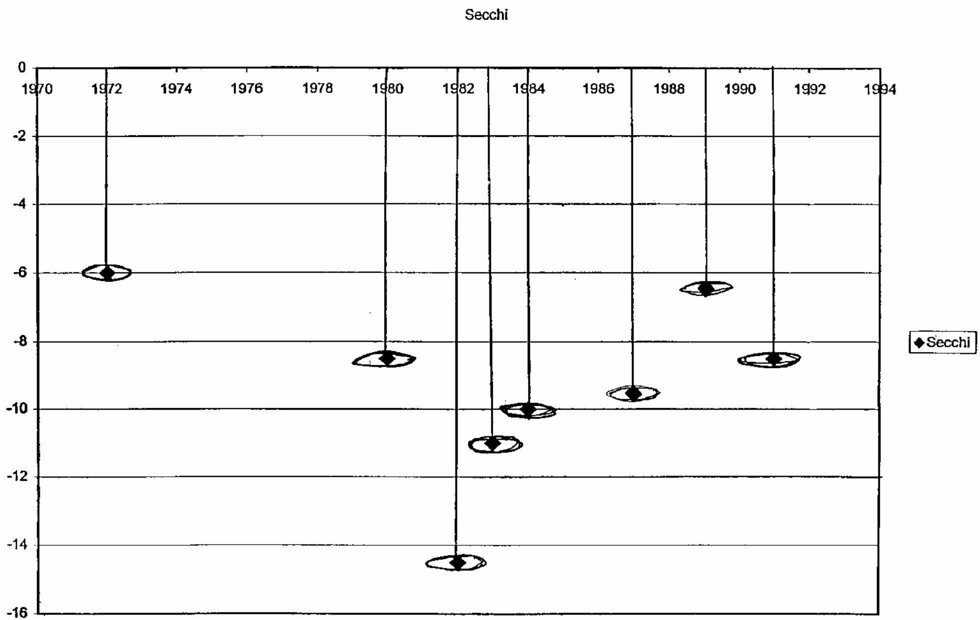
HISTORICAL REPORTS - WATER QUALITY & FISH, SECCHI CHART

UPPER LONG LAKE

Noble County

The water quality of Upper Long Lake was very marginal for trout. If better access existed it should be considered further for trout stocking. Without good access it should not be considered further as a potential coldwater fishery.

Upper Long Lake



ːIAL SURVEY

RE-SURVEY

x7 OTHER

LAKE Upper Long Lake

COUNTY Noble County

BIOLOGIST Melvin Taylor

DATE OF SURVEY August 25, 1972

DATE OF APPROVAL

1. QUADRANGLE NAME Merriam TWP. 34N 33N R. 9E S. 33 4

2. NEAREST TOWN Wolf Lake, Indiana

3. ACCESSIBILITY - STATE OWNED PUBLIC ACCESS SITE:
PRIVATELY OWNED PUBLIC ACCESS SITE:
OTHER: Semi-private access site for residents

4. SURFACE ACRES 86 MAXIMUM DEPTH 54 (FT.) AVERAGE DEPTH 22.1 (FT.) ACRE FT. 1902

5. WATER LEVEL 890.92 (MSL) EXTREME FLUCTUATIONS none

6. LOCATION OF BENCHMARK none

7. INLETS:
NAME Unnamed ditch LOCATION East side ORIGIN
NAME LOCATION ORIGIN
NAME LOCATION ORIGIN

8. OUTLET:
NAME Unnamed ditch LOCATION North end, flows to Dollar Lake

9. WATER LEVEL CONTROL Concrete sill dam

10.

POOL	ELEVATION (FEET MSL)	ACRES
TOP OF DAM		
TOP OF FLOOD CONTROL POOL		
TOP OF CONSERVATION POOL		
TOP OF MINIMUM POOL		
STREAMBED		

11. BOTTOM TYPE: BOULDER ___ GRAVEL ___ SAND ___ MUCK x CLAY ___ MARL x

12. WATERSHED USE: General farming

13. DEVELOPMENT OF SHORELINE: 30-40% developed, heavily channeled on east shore, one resort and one trailer court present

HOMES ___ BOATS ___ MARINAS ___ CAMPS ___ RESORTS 1

14. PREVIOUS SURVEYS AND INVESTIGATIONS: none

June 1971
GH:eh

SAMPLING EFFORT:

ELECTROFISHING: HOURS ______ TOTAL HOURS ______

GILLNETS: NUMBER ______ HOURS ______ TOTAL HOURS ______

TRAPS: NUMBER ______ HOURS ______ TOTAL HOURS ______

SHORELINE SEINING: NUMBER OF 100 FOOT SEINE HAULS ______

ROTENONE: GALLONS ______ ppm ______ ACRE FEET TREATED ______

PHYSICAL AND CHEMICAL CHARACTERISTICS

16. COLOR Green TURBIDITY 6.0 feet (SECCHI DISK)

17. TEMPERATURE: Air - 77°

DEPTH	DEGREES F.	DEPTH	DEGREES F.
SURFACE	77.0	40	48.5
2	77.0	42	48.0
4	77.0	44	48.0
6	77.0	46	47.0
8	77.0	48	47.0
* 10	76.5	50	47.0
12	72.0	52	47.0
14	70.0	54	46.0
16	68.0	56	
18	65.0	58	
20	61.5	60	
* 22	57.0	62	
24	54.5	64	
26	53.0	66	
28	52.0	68	
30	51.0	70	
32	50.5	72	
34	50.0	74	
36	49.5	76	
38	49.0	78	

18. D.O. - TOTAL ALKALINITY - pH :

DEPTH		D.O.		TOTAL ALKALINITY	pH
SURFACE		10.0		137.0	9.0
5		10.0			
10		10.0			
15		9.0			
20	17.5	0.8	1.4		
25		---			
30		0.0			
35		---			
40		0.0			
50		0.0		214.0	7.4

* Limits of thermocline: The limits of the thermocline were 10 and 24 feet.

/ X / INITIAL SURVEY

/ / RE-SURVEY

/ / OTHER

LAKE Upper Long Lake

COUNTY Noble

BIOLOGIST Jed Pearson

DATE OF SURVEY July 28-30, 1980 DATE OF APPROVAL 11-21-80 G.H.

1. QUADRANGLE NAME Merriam TWP. 34N 33N R. 9E S. 33 4

2. NEAREST TOWN Wolf Lake

3. ACCESSIBILITY - STATE OWNED PUBLIC ACCESS SITE:
PRIVATELY OWNED PUBLIC ACCESS SITE:
OTHER: Public ramp available at beach - owned by Association

4. SURFACE ACRES 86 MAXIMUM DEPTH 54 (FT.) AVERAGE DEPTH 22.1 (FT.) ACRE FT. 1,902

5. WATER LEVEL 890.92 (MSL) EXTREME FLUCTUATIONS None

6. LOCATION OF BENCHMARK None

7. INLETS:

NAME Unnamed ditch LOCATION east side ORIGIN

NAME LOCATION ORIGIN

NAME LOCATION ORIGIN

8. OUTLET:

NAME Unnamed ditch LOCATION North end, flows to Dollar Lake

9. WATER LEVEL CONTROL Concrete sill dam with basin and lip

10.

POOL	ELEVATION (FEET MSL)	ACRES
TOP OF DAM		
TOP OF FLOOD CONTROL POOL		
TOP OF CONSERVATION POOL		
TOP OF MINIMUM POOL		
STREAMBED		

11. BOTTOM TYPE: BOULDER ___ GRAVEL ___ SAND X MUCK X CLAY ___ MARL *

12. WATERSHED USE: General agriculture

13. DEVELOPMENT OF SHORELINE: Approximately two-thirds of the shoreline is developed for residential use.

14. PREVIOUS SURVEYS AND INVESTIGATIONS: Water quality check, IDNR, 1972

SAMPLING EFFORT:

ELECTROFISHING: DAY HOURS ______ NIGHT HOURS 1.0 TOTAL HOURS 1.0

GILL NETS: NUMBER 3 HOURS 48 TOTAL HOURS 144

TRAPS: NUMBER 3 HOURS 48 TOTAL HOURS 144

SHORELINE SEINING: NUMBER OF 100 FOOT SEINE HAULS ______

ROTENONE: GALLONS ______ ppm ______ ACRE FEET TREATED ______

PHYSICAL AND CHEMICAL CHARACTERISTICS

COLOR Blue-green TURBIDITY 8 FT. 6 INCHES (SECCHI DISK)

TEMPERATURE:

DEPTH	DEGREES F.	DEPTH	DEGREES F.
SURFACE	77.0	40	46.0
2	77.5	42	46.0
4	78.0	44	46.0
6	78.0	46	46.0
8	78.0	48	46.0
* 10	78.0	50	46.0
12	74.5	52	45.5
14	72.5	54	45.5
16	66.0	56	
18	58.5	58	
* 20	54.0	60	
22	52.0	62	
24	49.5	64	
26	49.0	66	
28	48.0	68	
30	47.0	70	
32	47.0	72	
34	46.5	74	
36	46.0	76	
38	46.0	78	

D.O. - TOTAL ALKALINITY - pH:

DEPTH	D.O.	TOTAL ALKALINITY	pH
SURFACE	7.0	120 ppm	9.0
5	7.0		
10	7.0		
15	6.0		
20	0.6		
25	0.0		
30	0.0		
35	0.0		
40	0.0		
50	0.0	137 ppm	7.5

*LIMITS OF THERMOCLINE:

19. COMMON SPECIES OF AQUATIC PLANTS

COMMON NAME	SCIENTIFIC NAME	DEPTH FOUND	PER CENT COVERED
Bulrush	Scirpus sp.	to 2'	Rare
Cattail	Typha sp.	to 1'	Common
Pickerelweed	Pontedaria sp.	to 2'	Rare
Spatterdock	Nuphar advena	to 3'	Rare
White lily	Nymphaea sp.	to 4'	Common
Yellow lily	Nymphaea sp.	to 4'	Common
Chara		to 4'	Abundant
Coontail	Ceratophyllum demersum	to 12'	Abundant
Milfoil	Myriophyllum spp.	to 8'	Common
Sago pondweed	Potamogeton pectinatus	to 8'	Rare

COMMENTS Residents report weed growth has dramatically increased the past few years. Some spatterdock areas appeared to have been treated. Weed control permits have been issued (1977). Residents requested grass carp. They have organized a fund raising effort to control weeds.

FISHES

20. SPECIES AND RELATIVE ABUNDANCE BY NUMBER AND WEIGHT

COMMON NAME	SCIENTIFIC NAME	NUMBER	(%)	WEIGHT (LBS.)	(%)
Bluegill	Lepomis macrochirus	302	47.0	16.50	14.7
Pumpkinseed	Lepomis gibbosus	58	9.0	3.44	3.1
Yellow bullhead	Ictalurus natalis	43	6.7	16.77	14.9
Redear	Lepomis microlophus	42	6.5	7.71	6.9
Largemouth bass	Micropterus salmoides	39	6.1	13.36	11.9
Lake chubsucker	Erimyzon sucetta	34	5.3	9.33	8.3
Warmouth	Lepomis gulosus	27	4.2	1.28	1.1
Yellow perch	Perca flavescens	27	4.2	2.41	2.1
Black crappie	Pomoxis nigromaculatus	23	3.6	7.13	6.3
Brown bullhead	Ictalurus nebulosus	14	2.2	10.44	9.3
Golden shiner	Notemigonus crysoleucas	14	2.2	.76	0.7
Green sunfish	Lepomis cyanellus	7	1.1	.17	0.2
Hybrid sunfish	Lepomis	4	0.6	.34	0.3
Spotted gar	Lepisosteus oculatus	3	0.5	9.98	8.9
Bowfin	Amia calva	2	0.3	10.09	9.0
Grass pickerel	Esox americus	2	0.3	.30	0.3
Northern pike	Esox lucius	1	0.2	1.67	1.5
White sucker	Catostomus commersoni	1	0.2	.71	0.6
		643		112.39	

21. NUMBER, PERCENTAGE, WEIGHT, AND AGE OF BLUEGILL

TOTAL LENGTH (inches)	NUMBER	PERCENTAGE	AVE.WEIGHT (pounds)	AGE
2.0	5	1.7	.01	I+
2.5	11	3.6	.02	I+,II+
3.0	60	19.9	.03	I+,II+
3.5	79	26.2	.04	II+,III+
4.0	35	11.6	.04	II+,III+
4.5	46	15.2	.05	III+,IV+
5.0	21	7.0	.08	III+,IV+,V+
5.5	18	6.0	.10	III+,IV+
6.0	12	4.0	.14	IV,V+,VI+
6.5	10	3.3	.17	IV+,VI+,VII+
7.0	4	1.3	.22	V+,VI+.VII+
7.5	1	0.3	.22	VII+
	302			

21. NUMBER, PERCENTAGE, WEIGHT, AND AGE OF PUMPKINSEED

TOTAL LENGTH (inches)	NUMBER	PERCENTAGE	AVE.WEIGHT (pounds)	AGE
3.0	1	1.7	.02	II+
3.5	11	19.0	.04	II+
4.0	19	32.8	.05	II+,III+,IV+
4.5	15	25.9	.06	III+,IV+
5.0	8	13.8	.09	III+,IV+,V+
5.5	3	5.2	.13	IV+
6.0	1	1.7	.14	IV+
	58			

21. NUMBER, PERCENTAGE, WEIGHT, AND AGE OF REDEAR

TOTAL LENGTH (inches)	NUMBER	PERCENTAGE	AVE.WEIGHT (pounds)	AGE
2.5	1	2.4	.01	I+
3.0	2	4.8	.02	I+,II+
4.0	1	2.4	.05	II+
4.5	5	11.9	.05	III+
5.0	7	16.7	.08	III+,IV+
5.5	2	4.8	.12	IV+
6.0	5	11.9	.16	V+
6.5	4	9.5	.19	V+
7.0	4	11.9	.27	IV+, V+, VI+
7.5	5	11.9	.32	V+,VI+
8.0	6	11.9	.38	VI+
	42			

21. NUMBER, PERCENTAGE, WEIGHT, AND AGE OF LARGEMOUTH BASS

TOTAL LENGTH (inches)	NUMBER	PERCENTAGE	AVE.WEIGHT (pounds)	AGE
4.0	1	2.6	.05	I+
4.5	4	10.3	.05	I+
5.0	2	5.2	.06	I+
5.5	1	2.6	.06	I+
6.0	1	2.6	.10	I+
7.0	1	2.6	.15	II+
7.5	6	15.4	.19	II+
8.0	4	10.3	.23	II+
8.5	5	12.8	.27	II+
9.0	6	15.4	.33	II+
9.5	2	5.2	.49	II+
10.0	1	2.6	.54	II+
11.0	1	2.6	.75	II+
12.5	2	5.2	.99	III+
13.0	1	2.6	1.10	IV+
16.0	1	2.6	1.94	VI+
	39			

21. NUMBER, PERCENTAGE, WEIGHT, AND AGE OF BLACK CRAPPIE

TOTAL LENGTH (inches)	NUMBER	PERCENTAGE	AVE. WEIGHT (pounds)	AGE
3.5	1	4.3	.04	I+
6.0	2	8.7	.12	II+
6.5	1	4.3	.15	II+
7.0	11	47.8	.18	II+
7.5	2	8.7	.21	II+
9.0	1	4.3	.35	IV+
10.0	1	4.3	.56	IV+
11.0	1	4.3	.65	---
11.5	1	4.3	.79	V+
12.0	1	4.3	.93	V+
12.5	1	4.3	1.05	VI+
	23			

Species	Year Class	Number	I	II	III	IV	V	VI
			Back Calculated Length					
Bluegill	1979	10	1.4					
	1978	13	1.1	2.4				
	1977	22	1.0	2.2	3.4			
	1976	10	1.0	2.1	3.5	4.9		
	1975	5	0.8	2.0	3.0	4.2	5.3	
	1974	5	0.8	2.0	3.2	4.7	5.6	6.1
Species	Average (Number)		1.0 (65)	2.1 (55)	3.3 (42)	4.6 (20)	5.5 (10)	6.1 (5)
Pumpkinseed	1979	0						
	1978	7	1.1	2.3				
	1977	14	1.1	2.4	3.7			
	1976	10	0.9	2.2	3.4	4.4		
Species	Average (Number)		1.0 (31)	2.3 (31)	3.6 (24)	4.4 (10)	( )	( )
Redear	1979	2	1.1					
	1978	2	1.0	2.4				
	1977	11	1.1	2.3	3.7			
	1976	4	0.7	2.4	3.7	4.8		
	1975	10	1.0	2.4	3.9	5.0	5.9	
Species	Average (Number)		1.0 (29)	2.4 (27)	3.8 (25)	4.9 (14)	5.9 (10)	( )
Largemouth bass	1979	9	2.4					
	1978	23	2.1	6.4				
	1977	2	2.7	7.9	10.2			
	1976	1	3.7	7.3	10.4	11.7		
	Average (Number)		2.7 (35)	7.2 (26)	10.3 (3)	11.7 (1)	( )	( )

Species	Year Class	Number	Back Calculated Length I	II	III	IV	V	VI
Black crappie	1979	1	1.7					
	1978	13	1.3	4.4				
	1977	0						
	1976	2	1.5	5.1	7.4	9.3		
	1975	2	1.3	5.1	8.7	10.1	11.1	
		Average (Number)	1.5 (18)	4.9 (17)	8.1 (4)	9.7 (4)	11.1 (2)	( )

Species	Year Class	Number	I	II	III	IV	V	VI
Northern pike	1979	1	13.3					
		Average (Number)	( )	( )	( )	( )	( )	( )

Species	Year Class	Number	I	II	III	IV	V	VI
		Average (Number)	( )	( )	( )	( )	( )	( )

Species	Year Class	Number	I	II	III	IV	V	VI
		Average (Number)	( )	( )	( )	( )	( )	( )

23. FALL SAMPLE

SPECIES	NUMBER	SIZE RANGE (INCHES)

24. FISH PARASITES AND DISEASES ______________________

____

____

25. EVIDENCE OF EROSION OR POLLUTION ______________________

____

____

26. OTHER SPECIES COLLECTED

SPECIES	LENGTH RANGE (INCHES)	WEIGHT RANGE (POUNDS)
Yellow bullhead	4.6 - 11.1	.04 - .86
Lake chubsucker	6.2 - 10.2	.13 - .49
Yellow perch	3.3 - 8.2	.02 - .25
Warmouth	2.9 - 5.0	.02 - .08
Brown bullhead	7.7 - 14.1	.20 - 1.35
Golden shiner	3.5 - 7.4	.03 - .16
Green sunfish	2.3 - 4.0	.01 - .05
Hybrid sunfish	2.9 - 5.5	.03 - .11
Spotted gar	25.1 - 30.7	2.25 - 4.38
Bowfin	21.5 - 25.5	3.40 - 6.69
Grass pike	7.5 - 9.8	.09 - .21
Northern pike	20.5	1.67
White sucker	11.8	.71

FISH MANAGEMENT PROJECT

LAKE Upper Long Lake

COUNTY Noble

BIOLOGIST Jed Pearson

FISH ERADICATION

A. RECOMMENDED MANAGEMENT: SELECTIVE ______ PARTIAL XX TOTAL ______ DRAINAGE ______

B. PISCICIDE: ANTIMYCIN XX ROTENONE ______

C. CONCENTRATION: 0.7 ~~(ppm)~~ (ppb) 8.61 ~~GAL.~~ OR ML./ACRE-FOOT

D. ACRE-FEET TO BE TREATED: to depth of 15 feet, volume is 1025 acre ft.

E. AMOUNT OF CHEMICAL: 8.825 ml

F. CHEMICAL COST: 18.4 units @ $50 each = $920

G. ESTIMATED DATE OF PROJECT: September, 1981

FISH STOCKING

A. TYPE: NEW INTRODUCTION ______ SUPPLEMENTAL XX NEW HABITAT ______

B.

SPECIES	NUMBER	SIZE	DATE
Largemouth bass*	8,600	4-6 inches	Fall, 1981

*marked by fin clips

GEH:EH
SEPT. 1975

Upper Long Lake
Noble County
Fish Management Report
1980

Introduction

Upper Long Lake is an 86 acre natural lake located near the town of Wolf Lake. Maximum depth is 54 feet and average depth is 22 feet. The lake basin is elongate along a north-south axis and lies at the headwaters of a tributary to the Elkhart River, South Branch watershed. Approximately two-thirds of the shoreline is developed for residential use. A public boat ramp, owned and maintained by the local residents, is available at the northeast end of the lake.

Water quality of Upper Long Lake is generally good. The water is clear (secchi reading of 8½ feet). Upper Long Lake stratifies between 10 and 20 feet deep. Adequate oxygen is available for fish down to 15 feet during summer. The dominant species of aquatic vegetation in Upper Long Lake are chara and coontail. Nearly all shallow shoreline areas are covered with dense beds of chara. Coontail is abundant around most of the basin to a depth of 12 feet.

At the request of local residents, a fish population survey was conducted by the Department of Natural Resources July 28-30, 1980. Objectives of the survey were to document current status of the fishery, to assess pike presence in the lake as part of the Elkhart River Pike Management Program, and to provide a basis for future fish management programs at Upper Long Lake. Sampling consisted of one hour of electrofishing, 144 gill netting hours, and 144 trap netting hours. The only previous work by the Department of Natural Resources at Upper Long Lake was a water quality check in 1972.

Results

A total of 643 fish, representing 18 species, was collected. Bluegill dominated the catch numerically (47%) and by weight (15%). Other major game species included pumpkinseed, yellow bullhead, redear, and largemouth bass. Nongame species were insignificant, comprising only 9% of the sample by number and 28% by weight. Lake chubsucker was the principal nongame species.

Bluegill ranged in length from 2.0 to 7.5 inches. However, bluegill 6.0 inches or longer comprised only 9% of the catch. Most bluegill (73%) were 3.0 to 4.5 inches long. Bluegill condition (weight per length) was average in comparison with other area lakes. However, bluegill growth in Upper Long Lake was below average, requiring six years to reach harvestable-size.

Pumpkinseed sunfish ranged from 3.0 to 6.0 inches long. Most (78%) were 3.5 to 4.5 inches long. Like bluegill, pumpkinseed sunfish exhibited average condition but below average growth. Redear exhibited the same pattern, average condition and slow growth. However, redear reached larger size. Redear up to 8.0 inches long were collected.

Thirty-nine largemouth bass were captured. These ranged from 4.0 to 16.0 inches long and represented ages one through six. Most bass (67%) were age 2 and were 7.0 to 11.0 inches long. Only four bass were larger than 12.0 inches. Bass generally exhibited average condition and growth, however, young bass grew slower than average.

Black crappie ranged in size from 3.5 inches (age 1) to 12.5 inches (age 6). Most crappies (70%) were 6.0 to 7.5 inches long and were age 2. Crappies exhibited average condition and growth.

Bullheads were relatively abundant in the catch. Forty-three yellow bullheads, 4.5 to 11.0 inches long, and 14 brown bullheads, 7.5 to 14 inches long, were collected. Other game species included warmouth, yellow perch, and green sunfish. One northern pike (age 1) was caught. It measured 20.5 inches long.

Nongame fish included lake chubsucker, golden shiner, spotted gar, bowfin, grass pickerel, and white sucker. Chubsuckers, shiners, and suckers provide forage for predator fish while numbers of other nongame species are low enough to be insignificant in the fishery.

Discussion and Recommendations

Although Upper Long Lake contains a satisfactory species composition, the lake does not provide good fishing for bluegill and other sunfish. Inadequate numbers of harvestable-size bluegill, redear, and pumpkinseed are available because growth of these species is poor.

Bluegill growth is determined by the amount of food available per individual fish. Where food is abundant, growth is good. Where food is scarce, growth is slow. At Upper Long Lake, the number of bluegill and other sunfish species exceeds the food supply.

Food production for bluegills at Upper Long Lake is low for several reasons. The lake is positioned at the headwaters of its watershed and receives smaller inputs of nutrients than many lakes. Many nutrients that are already in the lake, which could go into production of food organisms, are tied up in dense beds of aquatic vegetation.

Increasing nutrient availability at Upper Long Lake through weed control might stimulate production of food organisms and eventually increase fish growth. Local residents reported that vegetation, especially chara, has become more dense in recent years. They are currently conducting a fund raising effort to control vegetation. Removing excess cover provided by dense vegetation might also allow greater predation on young bluegill, thus stimulate bluegill growth.

Some residents are interested in stocking white amur (grass carp) in Upper Long Lake to control weeds. There is little evidence from various studies that introducing grass carp increases food production and improves bluegill growth (Bailey 1978). Area residents should also be aware that it is illegal to import, harbor, possess, or release grass carp into Indiana waters. More than 30 other states have a similar ban on grass carp because the affect this exotic fish may have on native fish populations is still unknown. The mistake of importing the European carp has been costly and conservationists are unwilling to stock grass carp without further research.

Large-scale weed control programs using various aquatic herbicides can have harmful side-effects, such as reduced water clarity, stimulation of nuisance algae blooms, and reduced gamefish recruitment. Weed control programs using herbicides are also expensive and provide only short term benefits. Therefore, at the present time, all weed control efforts at Upper Long Lake should be limited to chemical treatment of submergent vegetation in areas around docks and beaches. No treatment should be permitted along areas of undeveloped shoreline.

Bluegill growth can be increased by reducing bluegill numbers and reducing competition for food among sunfish. Bluegill numbers can best be reduced by chemically thinning the population coupled with increasing the predator population, primarily largemouth bass.

To improve growth of bluegill, redear, and pumpkinseed at Upper Long Lake and provide larger fish for harvest, antimycin should be applied at the rate of 0.7 ppb during fall 1981. Following treatment, largemouth bass fingerlings should be stocked at the rate of 100 fingerlings per acre. A 12 inch minimum size limit on largemouth bass should be implemented. [1/]

1/ Size limits are not currently administered on a lake by lake basis. However, a revised regulatory system is under study that would provide more regulatory flexibility. Pending changes in the regulatory framework, a 12 inch largemouth bass size limit is recommended for Upper Long Lake.

Prior to treatment, two public meetings should be held to inform local residents of the project. News media should also be contacted.

Submitted by: Jed Pearson, Fisheries Biologist
Date: 10/21/80

Approved by: Gary Hudson
Gary Hudson, Fisheries Supervisor
Date: 11/21/80

Approved by: William D. James
William D. James, Chief of Fisheries
Date: 11/28/80

INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE

HABITAT INSPECTION REPORT

Application Number:	PL-14,526
Location:	Upper Long Lake
County:	Noble
Applicant:	Upper Long Lake Association
Inspected By:	prior knowledge
Date:	
Comments By:	Jed Pearson
Date:	December 19, 1991

COMMENTS: The proposal to dredge an existing manmade channel at Upper Long lake will have little adverse effect on fish and wildlife habitat or on the natural character of the lake. Shoreline habitat which once existed here has already been altered by residential development. However, channels provide spawning and nursery areas for important sportfish, including largemouth bass. Dredging during spring months would interfere with fish spawning activity in the channel.

Therefore, the Division of Fish and Wildlife recommends approval of the project with the condition that all work be done in the last half of the calendar year.

Date 5/30/05 Replicate #

Time 11:00 AM

Station UPPER LONG LAKE (DEEP - ≈ 40 FT.)

LIGHT VERY IRREGULAR — SUN IN AND OUT OF CLOUDS. AIR TEMP. ABOUT 60°F, WINDY. LOTS OF VOLVOX FOUND IN PLANKTON SAMPLES.

TAXA (PER LITER)

Depth	Temp	DO	Light	Depth	Diaptomus	Cyclops	Daphnia
			A 1800				
0	15	9.4	B 1200	0_1	1.65	.23	4.00
1	15	9	540	0_2	3.06	.23	2.59
2	15	9.2	330	2_1	2.82		13.88
3	15	9.1	190	2_2	1.88	.47 ~~.23~~	6.82
4	15	9.3	120	4_1	2.82	.23 ~~.23~~	6.82
5	15	9.2	75	4_2	2.35	.23	12.00
6	12	4.9	39	6_1	.23	.70 ~~.70~~	5.88
7	10.5	4.2	23	6_2	.70	.70 ~~.23~~	1.41
8	10	4.2	13	8_1	.23		.47
9	9.5	4.1	7.2	8_2	.47	.23	.47
10	8	4.1	3.7	10_1	.47		.47
11	7.5	4.3	2.1	10_2	.94		.70
12	7	4.1	3	12_1	.23	.23	.94
13	7	2.6	.9	12_2	1.65		.47
14							
15							
16							
17							
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21							
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25							
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28							
29							
30							

July 28, 1982

15. SAMPLING EFFORT:

ELECTROFISHING: DAY HOURS ______ NIGHT HOURS 1 hr. 10 min. TOTAL HOURS 1.2

GILL NETS: NUMBER 4 HOURS 24 TOTAL HOURS 96

TRAPS: NUMBER 4 HOURS 24 TOTAL HOURS 96

SHORELINE SEINING: NUMBER OF 100 FOOT SEINE HAULS ______

ROTENONE: GALLONS ______ ppm ______ ACRE FEET TREATED ______

PHYSICAL AND CHEMICAL CHARACTERISTICS

16. COLOR Blue TURBIDITY 14 FT. 6 INCHES (SECCHI DISK)

17. TEMPERATURE: Air: 74.5^{o}F, July 28-29, 1982, partly cloudy

DEPTH	DEGREES F.	DEPTH	DEGREES F.
SURFACE	80.5	40	47.5
2	81.0	42	47.0
4	81.5	44	47.0
6	81.5	46	47.0
8	81.5	48	47.0
* 10	80.0	50	47.0
12	76.5	52	47.0
14	72.0	54	
16	67.0	56	
* 18	58.5	58	
20	56.0	60	
22	55.5	62	
24	53.0	64	
26	51.0	66	
28	50.0	68	
30	49.5	70	
32	49.0	72	
34	48.0	74	
36	48.0	76	
38	48.0	78	

18. D.O. - TOTAL ALKALINITY - pH:

DEPTH	D.O.	TOTAL ALKALINITY	pH
SURFACE	8.0 ppm	154 ppm	9.5
5	7.0		
10	8.0		
15	5.0		
20	0.6		
25	0.4		
30	Trace		
35	Trace		
40	Trace		
45	Trace		
50	Trace	205 ppm	8.0

*LIMITS OF THERMOCLINE:

Upper [illegible] [illegible] 1, 1983

15. SAMPLING EFFORT: (Shock [illegible])

ELECTROFISHING:	DAY HOURS ____	NIGHT HOURS 1.0	TOTAL HOURS 1.0
GILL NETS:	NUMBER 3	HOURS 48	TOTAL HOURS 144
TRAPS:	NUMBER 4	HOURS 48	TOTAL HOURS 192
SHORELINE SEINING:	NUMBER OF 100 FOOT SEINE HAULS ____		
ROTENONE:	GALLONS ____	ppm ____	ACRE FEET TREATED ____

PHYSICAL AND CHEMICAL CHARACTERISTICS

16. COLOR blue TURBIDITY 11 FT. 0 INCHES (SECCHI DISK)

17. TEMPERATURE: Clear Air 74°

DEPTH	DEGREES F.	DEPTH	DEGREES F.
SURFACE	80.0	40	50.0
2	81.0	42	49.5
4	81.0	44	47.5
6	81.5	46	49.0
8	81.5	48	49.0
10	81.5	50	48.5
*12	81.0	52	48.5
14	78.0	54	
16	71.0	56	
18	66.5	58	
20	63.0	60	
*22	60.0	62	
24	[illegible]	64	
26	56.	66	
28	[illegible]	68	
30	[illegible]	70	
32		72	
34	[illegible]	74	
36	[illegible]	76	
38	[illegible]	78	

18. D.O. - TOTAL ALKALINITY - pH:

DEPTH	D.O.	TOTAL ALKALINITY	pH
SURFACE	7.0	[illegible]	7.5
5	7.0		
10	7.0		
15	4.0		
20	1.5		
25	0.5		
30	tr		
35	tr		
40	tr		

*LIMITS OF THERMOCLINE: tr tr 8X171 8.0

July 24-26, 1984

15. SAMPLING EFFORT:

ELECTROFISHING: DAY HOURS ______ NIGHT HOURS 1.0 TOTAL HOURS 1.0

GILL NETS: NUMBER 3 HOURS 48 TOTAL HOURS 144

TRAPS: NUMBER 4 HOURS 48 TOTAL HOURS 192

SHORELINE SEINING: NUMBER OF 100 FOOT SEINE HAULS ______

ROTENONE: GALLONS ______ ppm ______ ACRE FEET TREATED ______

PHYSICAL AND CHEMICAL CHARACTERISTICS

16. COLOR blue TURBIDITY 10 FT. 0 INCHES (SECCHI DISK)

17. TEMPERATURE: air 74°

DEPTH	DEGREES F.	DEPTH	DEGREES F.
SURFACE	76.5	40	50.5
2	77.0	42	50.0
4	77.5	44	50.0
6	78.0	46	49.0
8	77.5	48	49.0
10	76.5	50	48.0
12	76.0	52	48.0
14	75.0	54	48.0
16	70.0	56	
18	61.5	58	
20	57.0	60	
22	56.0	62	
24	55.0	64	
26	54.0	66	
28	53.5	68	
30	53.0	70	
32	52.5	72	
34	52.5	74	
36	52.0	76	
38	51.0	78	

18. D.O. - TOTAL ALKALINITY - pH:

DEPTH	D.O.	TOTAL ALKALINITY	pH
SURFACE	7.0	7 X 17.1	9.5
5	7.0		
10	7.0		
15	6.0		
20	1.5		
25	trace		
30	trace		
35	trace		
40	trace		
	0		

*LIMITS OF THERMOCLINE: 50'-0 11 X 17.1 8.0

15. SAMPLING EFFORT

ELECTROFISHING	Day Hours	Night Hours ½ hr all	Total Hours ½ bass	GILL NETS	Number 3	Hours 48	Total Hours
TRAPS	Number 4	Hours 48	Total Hours 192	SHORELINE SEINING	Number of 100 Foot Seine Hauls		
ROTENONE	Gallons	ppm	Acre Feet Treated				

16. PHYSICAL AND CHEMICAL CHARACTERISTICS

Color	Turbidity
blue	9 Ft. 6 Inches (SECCHI DISK)

17. TEMPERATURE

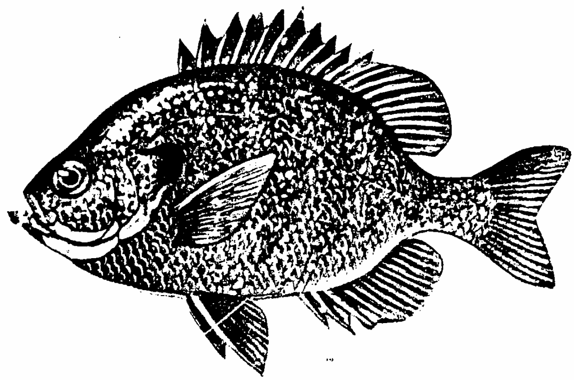
DEPTH FEET	DEGREES F 82 air	DEPTH FEET	DEGREES F
SURFACE	82.0	40	46.0
2	80.5	42	46.0
4	80.0	44	45.5
6	80.0	46	
8	79.0	48	
10	78.0	50	45.5
12 *	76.0	52	45.0
14	72.0	54	45.0
16	67.0	56	
18	62.0	58	
20	57.5	60	
22	54.0	62	
24 *	51.0	64	
26	50.0	66	
28	48.5	68	
30	47.5	70	
32	47.0	72	
34	46.5	74	
36	46.0	76	
38	46.0	78	

18. D.O. — TOTAL ALKALINITY — PH:

DEPTH FEET	D.O ppm	ALKALINITY ppm	pH	Comments
SURFACE	10.0	103	9.5	
5	9.0			
10	9.0			
15	6.0			
20	0.5			
25	0			
30	0			
35	0			
40	0			
54'		154	7.5	

*LIMITS OF THERMOCLINE

LONG-TERM CHANGES IN THE FISH POPULATION AT UPPER LONG LAKE FOLLOWING ANTIMYCIN TREATMENT



Jed Pearson, Fisheries Biologist

FISHERIES SECTION
INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
607 State Office Building
Indianapolis, Indiana 46204

1987

Abstract

Following a 0.7 ppb antimycin application in 1981 to reduce excessive numbers of slow-growing bluegills at an 86 acre northeast Indiana lake, the electrofishing catch rate of bluegills decreased 95% in 1982 and the trap net catch rate decreased 90%. By 1984, catch rates exceeded pre-treatment catch rates. The electrofishing catch rate of largemouth bass, following a stocking of 130 fingerlings per acre doubled over the pre-treatment catch rate.

Surviving bluegills spawned in 1982, producing a large fast-growing year class which dominated the population through 1987. However, subsequent bluegill year classes grew at rates similar to pre-treatment growth rates. Bluegill PSDs increased from 9% prior to treatment to 64% immediately after and was 46% six years after treatment.

This project demonstrated antimycin treatments can reduce overabundant bluegill populations and increase bluegill size in diverse fish communities without triggering unwanted increases in numbers of less desirable fish. However, improvements in bluegill size and growth rates were not sustained.

LONG-TERM CHANGES IN THE FISH POPULATION AT UPPER LONG LAKE FOLLOWING ANTIMYCIN TREATMENT

Slow-growing bluegill populations are present in some northeast Indiana natural lakes. Although the problem is not widespread, there are enough lakes where it occurs that experimental programs are needed to find inexpensive, biologically sound ways to improve bluegill growth.

The most applicable technique for improving bluegill growth may be the reduction of bluegill numbers by selective chemical fish toxicants followed by predator stockings. Other techniques, such as habitat modifications (water level drawdowns, fertilization, aquatic weed control), are not practical and possibly harmful while population manipulations (predator fish harvest restrictions) have not consistently improved fishing in the natural lakes.

Antimycin, a selective fish toxicant, can be used to reduce fish densities. It's inexpensive, degrades quickly, and has no long-term adverse impacts on lake ecology. To date, little is known about the effectiveness of antimycin treatments in natural lakes where species diversity is high. Excessive reductions of fish densities may be needed to stimulate significant increases in bluegill growth. This could reduce harvest and yield or trigger increases in numbers of less desirable fish. Secondly, bluegill growth may again slow down as the population recovers if the original cause of poor growth is not corrected.

UPPER LONG LAKE

Upper Long Lake is an 86 acre natural lake located near the town of Wolf Lake (Figure 1). The lake basin is elongate along a north-south axis and lies at the headwaters of a tributary to the Elkhart River South Branch. About two-thirds of the shoreline is developed for residential use and the surrounding area is primarily agricultural.

Maximum depth of Upper Long Lake is 54 feet and the average depth is 22 feet. Water quality is generally good. The water is relatively clear (8½-11 feet secchi disc readings). The lake stratifies between 10 and 20 feet deep. Adequate oxygen is available for fish down to 15 feet deep during summer. Slightly more than half (53%) of the lake's water volume is less than 15 feet deep. Nearly all the shoreline areas are covered with dense beds of chara. Coontail is abundant around most of the basin to a depth of 12 feet.

Prior to antimycin treatment, Upper Long Lake was dominated by slow-growing bluegills, redear, and pumpkinseed sunfish. Bluegills ranged from 2-7½ inches long but only 9% were 6 inches or larger. They required 6 years to reach 6 inches long, while bluegills in most area lakes reach 6 inches in 4 years. Nearly all pumpkinseed sunfish were less than 6 inches long. Redear between 6 and 8 inches long were present but were 5 and 6 years old.

The predator population at Upper Long Lake was typical of most area lakes. Based on catch rates, bass abundance was average. Spotted gar, bowfin, and northern pike were present but in low numbers. Adult black crappie and yellow perch were also present but in low numbers.

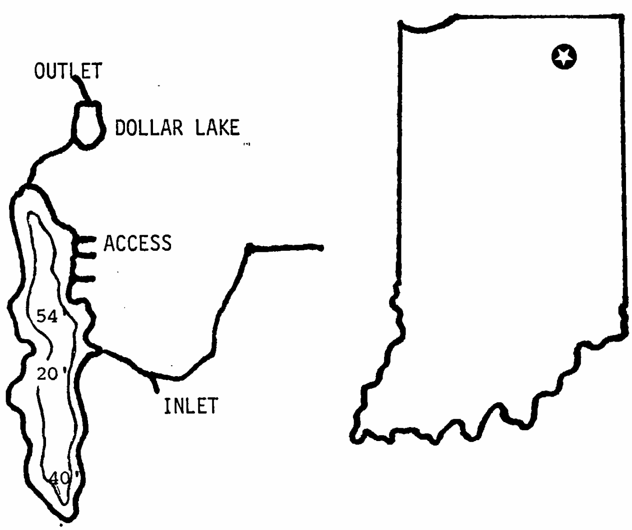
To improve growth of bluegills and other sunfish species at Upper Long Lake, 13 units of Fintrol® concentrate with 10% active ingredient (antimycin

A) were applied on October 7, 1981. The toxicant was applied at a rate of 0.7 ppb to a depth of 15 feet (1,000 acre feet of water). Cost of the toxicant was $650.00. Following the treatment, approximately 10,300 largemouth bass fingerlings (3-4 in) and 912 sub-adult bass ($\overline{TL}$=6½ in) were restocked.

Although dead fish were not counted or weighed, it appeared the kill from the treatment was light. Few dead fish were observed along the shore. Most of the dead fish were small bluegills. A few dead adult white suckers were also noted.

Follow-up annual fish population surveys were conducted during midsummer 1982-1984 to determine the extent of the kill and monitor initial changes in fish abundance and growth. Sampling effort consisted of 1.2 hours of AC electrofishing in 1982, 1 hour in 1983 and 1984. Four gill nets and four trap nets were set for a total of 96 hours per gear in 1982 while seven overnight gill net sets and eight trap net sets were made for 144 gill net hours and 192 trap net hours in 1983 and 1984. In 1980, prior to the treatment, sampling consisted of one hour of electrofishing, 144 gill net hours, and 144 trap net hours.

Figure 1. Upper Long Lake.



In 1987, another survey was conducted at Upper Long Lake to examine the long-term effects of the antimycin treatment and to sample for walleyes stocked in 1986. Three gill nets and four trap nets were set for 48 hours each. In addition, DC electrofishing was conducted for ½ hour to collect all fish and for another ¼ hour to collect more bass.

CHANGES IN FISH ABUNDANCE

Based on the survey catches, there was a substantial decrease in the number of bluegills immediately following the antimycin treatment (Table 1). Within two years, they returned to their pre-treatment abundance level.

The AC electrofishing catch rate of bluegills declined from 172 bluegills per hour in 1980 to only eight bluegills per hour in 1982 (95% decrease). In 1983, the catch rate increased to 127 bluegills per hour and by 1984, the catch rate increased to 245 bluegills per hour. In 1987, the DC electrofishing catch rate was 174 bluegills per ½ hour. The trap netting catch rate changed from 83 bluegills per 100 hours in 1980 to only eight bluegills per 100 hours in 1982 (90% decrease), then increased to 96 bluegills per 100 hours in 1983, 91 bluegills per 100 hours in 1984, and 154 bluegills per 100 hours in 1987.

Pumpkinseed and redear sunfish numbers changed little after the treatment. Although the electrofishing catch rates of both species in 1983 were half of the 1980 rates, the trap net catch rates about doubled in 1983. In 1984 and 1987, the number of pumpkinseed sunfish decreased. Also unaffected by the antimycin treatment were bullheads.

There were small decreases in numbers of warmouth and black crappies immediately after the treatment. They returned to their previous abundance levels within two years but decreased again by 1987. Spotted gar, scarce prior to the kill, dissappeared from the 1982 catch but returned in 1983.

Table 1. Number and weight of fish collected during surveys before and after antimycin treatment at Upper Long Lake.

	NUMBER					POUNDS				
Species	1980	1982	1983	1984	1987	1980	1982	1983	1984	1987
Bluegill	302	33	345	409	542	16.5	6.3	15.0	29.8	58.9
Pumpkinseed	58	60	71	27	25	3.4	5.9	6.5	2.2	1.2
Redear	42	51	55	68	56	7.7	7.4	4.5	6.3	6.3
Largemouth bass	39	95	88	78	113	13.4	21.8	17.8	24.9	41.3
Warmouth	27	11	44	28	14	1.3	1.2	5.0	3.8	1.9
Yellow perch	27	1	4	10	19	2.4	0.2	0.3	2.1	2.1
Black crappie	23	9	19	6	1	7.1	3.5	4.8	1.6	0.8
Other sunfish	11	9	5	4	15	0.5	0.9	0.7	0.3	0.4
Bullheads	57	43	83	36	71	27.2	19.9	39.7	15.6	27.1
Northern pike	1	3	4	7	4	1.7	15.6	3.6	21.6	31.6
Lake chubsucker	34	5	31	38	35	9.3	1.5	2.0	4.3	9.4
Golden shiner	14	1	6	4	1	0.8	-	0.4	0.6	0.2
Spotted gar	3	0	3	4	8	10.0	-	5.6	15.5	16.3
Bowfin	2	1	2	4	0	10.1	.7	7.0	6.6	-
Grass pickerel	2	2	2	2	2	0.3	-	0.3	0.4	0.7
White sucker	1	5	7	8	5	0.7	5.6	12.6	13.0	11.3
Carp	0	1	4	4	1	-	17.3	9.4	40.5	6.4
Other suckers	0	0	2	0	0	-	-	3.3	0	-
Totals	643	330	775	737	912	112.4	107.8	138.5	189.1	215.9

Among other nongame fish, lake chubsuckers and golden shiners decreased immediately after the treatment. Chubsuckers have returned to their pre-kill abundance levels but golden shiners have not. White suckers and carp increased slightly in the catch but remain scarce. Two additional sucker species, spotted sucker and shorthead redhorse, appeared in the 1983 catch but were not caught again in 1984 or 1987.

Besides the sharp decrease in bluegill numbers after the treatment and their return in 1983, the only other significant changes in fish abundance involved largemouth bass and yellow perch. Largemouth bass abundance increased following the restocking of fingerling bass. The AC electrofishing catch rate of bass doubled from 39 bass per hour in 1980 to 76 bass per hour in 1982 and 74 bass per hour in 1983 and 1984. In 1987, 107 bass were captured in 3/4 hour of DC electrofishing. The number of perch declined after the treatment but recovered.

CHANGES IN FISH SIZE

Prior to antimycin treatment, bluegills were 2-7½ inches long and averaged 4 inches long (Table 2). Bluegills 4½ inches or smaller made up 78% of the catch. Only five bluegills (2%) were 7 inches or larger. The Proportional Stock Density (PSD) was 9%. This means only 9% of all bluegills 3 inches or larger were 6 inches or larger.

Immediately after the treatment, no bluegills smaller than 4½ inches (the primary target fish) were collected. The 33 bluegills collected ranged from 4½-8 inches long and averaged 6 inches long. Over 39% were 7 inches or larger. The PSD increased from 9% in 1980 to 64% in 1982.

Surviving bluegills successfully spawned in 1982 so the 1983 survey catch was dominated by age 1 fish. These ranged from 1½-4½ inches long and made up 93% of the catch. The remaining bluegills were 5½-9 inches long.

Table 2. Length-frequency distribution of bluegills collected at Upper Long Lake.

Inches	1980	1982	1983	1984	1987
1-1½	0	0	0.3	0.2	0.2
2-2½	5.3	0	31.9	5.4	6.8
3-3½	46.1	0	48.4	23.2	13.4
4-4½	26.8	21.2	12.2	22.5	12.3
5-5½	13.0	15.2	0.3	31.0	24.3
6-6½	7.3	24.2	0.3	15.6	27.7
7-7½	1.6	36.4	4.6	1.7	15.0
8-8½	0	3.0	1.7	0	0.2
9+	0	0	0.3	0.2	0
Number	302	33	345	409	542

Overall, bluegills averaged 3½ inches long. Bluegills 7 inches or larger made up 7% of the catch. Their PSD was 12%.

By 1984, the average length of bluegills increased to 4½ inches. They ranged from 1-9 inches long. Most were age 2 bluegills measuring 3-7 inches long. Their PSD was 19%, slightly below what is considered optimum for bluegill population structure (20-40%). However, the percentage of bluegills 7 inches or larger was still low (2%).

Six years after treatment, average length of bluegills was 5¼ inches and they ranged from 1½-8 inches long. PSD increased to 46%. The percentage of 7 inch and larger bluegills (15%) was also higher. Several of these fish were survivors from the strong year class produced in 1982 after the treatment.

Pumpkinseed sunfish, prior to the treatment, ranged from 3-6 inches long. They averaged 4½ inches long. Unlike bluegills, a large year-class of pumpkinseed sunfish did not appear in 1982 after the treatment. In the 1983 catch, pumpkinseed sunfish were 2½-6½ inches long and averaged 5 inches long. The percentage of pumpkinseed sunfish 6 inches or larger increased from 2% before the treatment to 20% in 1983 and 22% in 1984. They were 2½-7½ inches long in 1984 and averaged 4½ inches. By 1987, pumpkinseeds average length decreased to 4¼ inches and only one pumpkinseed sunfish larger than 5 inches was collected. Most pumpkinseeds in 1987 were 3 years old.

Redear sunfish, prior to treatment, ranged from 2½-8 inches and averaged 6 inches long. Redear 6 inches or larger made up 57% of the catch. After treatment, redear were 2½-9 inches long. However, the appearance of a larger year class in 1982 (age 1 fish in 1983) reduced the overall mean length of redear to 4½ inches and the percentage of redear 6 inches or larger declined to 16%. In 1984, redear 2-10 inches long were collected. Average redear length stayed the same (4½ inches) but the percentage of redear 6 inches or larger declined to 10%. By 1987, average redear length increased (5½ inches) but their size range narrowed to 2½-7 inches. The strong 1982 year class was still present.

Largemouth bass were 4-16 inches long prior to the antimycin treatment. The population was dominated by one and two-year old bass (92%) that were less than 12 inches long. Their PSD (% ≥ 12 inches of all bass ≥ 8 inches) was 18%.

In the 1982 survey catch following the restocking of fingerlings and successful reproduction by the adults, the bass size distribution shifted to even smaller fish. They ranged from 2-14½ inches. Only two bass were larger than 12 inches (2%). The bass PSD dropped from 18% in 1980 to 6% in 1982.

In the 1983 survey catch, all bass were less than 12 inches long (PSD=0%). They ranged from 4-11½ inches. Most were age 1 or age 2 bass. No young-of-the-year bass were collected. Age 2 and 3 bass dominated the catch in 1984. Although no bass larger than 13½ inches were caught, the PSD increased to 7%. This PSD, however, is much below what is considered optimum for bass (40-60%). By 1987, bass PSD increased to 25%. They ranged from 2-20½ inches long. Age 2 and 3 bass still dominated the catch. Five young-of-the-year bass were caught.

CHANGES IN FISH WEIGHTS

There was little change in the mean weights of sunfish after the antimycin treatment (Table 3). Mean weights per half-inch group of redear and pumpkinseed sunfish didn't change while mean weights of 5½-7½ inch bluegills increased slightly (20-40%) in 1982 and 1983 but decreased to pre-treatment weights by 1984. Six years later, weights of small sunfish were similar or less than weights of sunfish before the treatment.

CHANGES IN FISH GROWTH

The most significant improvements following the antimycin treatment were increases in growth. However, the improvements didn't last. Mean length at

Table 3. Mean weights of fish at Upper Long Lake before and after antimycin treatment.

	BLUEGILL					REDEAR					PUMPKINSEED				
Inches	'80	'82	'83	'84	'87	'80	'82	'83	'84	'87	'80	'82	'83	'84	'87
3.5	.04	-	.02	.03	.02	-	.03	.03	.03	.03	.04	-	.03	.03	.02
4.0	.04	-	.04	.04	.04	.05	.05	.04	.04	.06	.05	.05	.04	.04	.03
4.5	.05	.06	.05	.05	.05	.05	.07	.06	.06	.06	.06	.07	.07	.05	.04
5.0	.08	.08	-	.07	.07	.08	.10	.09	.08	.08	.09	.10	.09	.09	.08
5.5	.10	.11	.12	.10	.10	.12	.12	.11	.11	.12	.13	.13	.12	.13	-
6.0	.14	.16	.17	.14	.13	.16	.16	.16	.18	.15	.14	.14	.16	.14	.15
6.5	.17	.22	-	.17	.18	.19	.20	.12	-	.18	-	-	.20	.17	-
7.0	.22	.26	.26	.23	.23	.27	.26	.27	-	.26					
7.5	.22	.34	.31	.27	.27	.32	.30	-	-	-					
8.0	-	.35	.38	-	.31	.38	.42	-	-	-					
8.5	-	-	.42	-	-	-	-	.52	.40						

time of capture (Table 4) and back-calculated lengths at each age (Table 5) of bluegills, redear, and pumpkinseed sunfish were larger in 1982 and 1983 for all age-groups.

In 1983, age 1 bluegills, the first age-group produced after the treatment, were 38% larger than age 1 bluegills in 1980. Age 1 redear in 1983 were 21% larger than 1980. However, mean lengths of age 1 bluegills and redear decreased to pre-treatment lengths by 1984, demonstrating growth improvements were short-term. Mean lengths at each age for pumpkinseed sunfish also increased in 1983 but declined by 1987.

Young bass were larger after the antimycin treatment. However, since many of the bass were stocked, comparisons of in-lake growth before and after the treatment cannot be made using 1982 and 1983 growth data. Age 1 bass in 1984, however, were 14% larger than age 1 bass in 1980, reflecting a short-term increase in young bass growth. However, mean lengths of bass 6 years later were less than mean lengths before the antimycin application.

MANAGEMENT IMPLICATIONS

Although it appeared the fish kill at Upper Long Lake was small following the 1981 antimycin application, there was a substantial decrease in the number of small bluegills, the primary target fish. The initial objective of reducing bluegill numbers and stimulating bluegill growth was achieved. Larger bluegills became available to fishermen. Abundance of non-target fish did not change appreciably. The number of bass increased following stocking.

However, improvements in bluegill size and growth were not sustained. Six years after treatment, bluegill mean lengths and back-calculated lengths at each age were similar to pre-treatment averages. The population still contained larger bluegills in 1987 than in 1980 but many were fish which had grown fast in the initial years after the antimycin application. Once these older bluegills (1982 year class) are gone, average size of bluegills in

Upper Long Lake will decrease.

Despite the larger bass population, there was not enough predation to sufficiently control bluegill population expansion. It's unlikely that the walleye stocking will affect the bluegill population as survival was apparently poor. None were collected from an August 1986 stocking of 1,000 walleye fingerlings (4 inch), paid for by local residents.

While this project demonstrated a single antimycin treatment can reduce an overabundant bluegill population in a highly diverse fish community without triggering unwanted increases in less desirable fish, improvements in bluegill size and growth did not last. Whatever conditions (e.g. low productivity, excessive weed growth, etc.) led to poor bluegill growth prior to 1980 are still present. More research is needed to isolate causes of poor bluegill growth in northeast Indiana natural lakes and to find ways to improve and sustain bluegill growth.

Submitted by: Jed Pearson, Fisheries Biologist
Date: 11/16/87

Approved by: Gary Hudson
Gary Hudson, Fisheries Supervisor

Date: 11/18/87

Table 4. Mean length (inches) of fish collected at Upper Long Lake before and after antimycin treatment.

Species		AGE 1	2	3	4	5
Bluegill	1980	2.4	3.3	4.7	5.8	6.0
	1982	-	4.4	5.0	6.8	7.0
	1983	3.3	-	6.9	7.2	7.0
	1984	2.5	4.8	-	-	7.5
	1987	2.4	3.3	4.6	5.7	6.9
Redear	1980	2.8	3.6	4.8	5.7	6.5
	1982	-	5.1	6.4	6.3	8.1
	1983	3.4	4.8	6.4	-	-
	1984	2.3	4.6	-	-	9.3
	1987	2.5	3.5	4.6	5.1	5.8
Pumpkinseed	1980	-	3.4	4.5	5.1	5.1
	1982	-	4.4	5.2	5.6	5.8
	1983	3.7	4.8	5.6	6.1	-
	1984	2.3	6.3	5.0	7.0	-
	1987	-	-	3.9	4.7	5.2
Bass	1980	4.9	8.5	12.4	13.0	
	1982	6.3	8.8	10.5	14.4	
	1983	5.3	8.6	10.7	11.0	
	1984	5.6	7.9	10.8	13.2	
	1987	4.5	7.6	10.3	12.4	

Table 5. Back-calculated length* in inches at each age at Upper Long Lake before and after antimycin treatment.

Species		AGE 1	2	3	4	5
Bluegill	1980	1.7	2.6	3.6	5.0	5.4
	1983	1.9	-	5.6	6.1	5.9
	1984	1.7	3.6	-	-	7.2
	1987	1.6	2.5	3.5	5.1	6.5
Redear	1980	1.6	2.6	3.9	4.9	6.0
	1983	2.0	3.6	4.9		
	1984	1.7	3.5	-		
	1987	1.6	2.6	3.8	4.3	5.4
Pumpkinseed	1980	-	2.6	3.8	4.5	4.8
	1983	2.2	3.6	4.6	5.7	-
	1984	1.6	4.7	4.5	6.4	-
	1987	-	-	3.2	4.0	5.1
Bass	1980	2.8	6.6	10.3		
	1983	3.4	7.1	9.3		
	1984	3.6	6.3	9.5		
	1987	2.5	5.7	8.5		

*based only on fish of each age-group and not year-class averages.

UPPER LONG LAKE
NOBLE COUNTY
FISH POPULATION SURVEY
1991

Upper Long Lake is an 86-acre natural lake located near the town of Wolf Lake in western Noble County. It lies at the headwaters of a tributary to the Elkhart River South Branch. Over half of the shoreline is residential. Most of the surrounding watershed is agricultural.

A public boat launching area and beach are present near the northeast corner of the lake. The property is owned by the local lake association. No fee is charged for launching but parking space is limited.

Maximum depth of Upper Long Lake is 54 feet and average depth is 22 feet. The lake is relatively clear (8-11 feet secchi readings). Water quality is also good and has changed little over the past two decades. The lake's trophic index was listed at 32 in the 1970s and late 1980s.

In July 1991 trace amounts of oxygen were present down to 40 feet. Adequate amounts (≥5 ppm) were present down to 15 feet and again at 25 feet. The lake was thermally stratified at 10-18 feet where temperatures dropped from 75F to 58F.

The bottom consists of sand and marl. Nearly all shallow shoreline areas are covered with chara. Coontail is also abundant in deeper offshore areas. The dominant emergent plants are cattails and lilies interspersed along most of the shore. Non-native purple loosestrife, milfoil or curly-leaf pondweed are not evident.

Management History

The first fish population survey at Upper Long Lake was conducted in 1980. At the time, slow-growing bluegills and other small panfish were present. Less than 10% of stock-size bluegills (≥3 in) were 6 inches or larger. Less than 2% were 7 inches long. Bluegills required as many as 6 years to reach 6 inches long.

To reduce densities of small panfish and improve bluegill growth, 13 units of Fintrol® concentrate with 10% active ingredient (antimycin) were applied at a rate of 0.7 ppb to the lake in 1981. After the treatment, 10,300 largemouth bass fingerlings and 912 sub-adult bass were restocked.

Annual follow-up surveys from 1982-1984 indicated bluegill numbers were reduced. The AC electrofishing catch rate decreased from 172/hour before the project to 8/hour after. Bluegill growth increased. Age-3 fish were over 2 inches larger in 1983 compared to 1980 and age-4 fish were more than 1 inch larger. However, these improvements did not last.

By 1984, the electrofishing catch rate rebounded to 245/hour. By 1987, age-3 and age-4 bluegills were growing slowly again. Small bluegills dominated the lake despite the larger bass population.

To boost the number of predators and provide additional fishing opportunity, local residents stocked 1,000 walleye fingerlings in 1986. None were found during a 1987 survey. Residents are now seeking to improve access and reduce nutrient and sediment runoff to the lake.

At the request of the lake association, another fish population survey was conducted on July 15-17, 1991. Purposes of the survey were to obtain current information on the fish population and to provide additional recommendations for improving fishing.

Sampling consisted of 30 minutes of DC electrofishing for all fish plus 15 more minutes for bass, six gill net lifts and eight trap net lifts. One month prior to the survey (June 17), electrofishing was conducted for 45 minutes to assess bluegill density and size. Also in June, fishermen were contacted on four days to evaluate bluegill fishing.

1991 Survey Results

During the 1991 survey, 1,058 fish weighing 236 pounds and respresenting 20 species were collected. Bluegills comprised half of the catch and accounted for 18% of the weight. Redear and largemouth bass each made up 10% of the catch. However, bass ranked first by weight (21%). Yellow bullheads were

Number, size and weight of fish collected at Upper Long Lake in July 1991.

Species	Number	Inches	Pounds
Bluegill	529	1.5-7.8	41.57
Redear	111	2.2-8.4	12.71
Largemouth bass	109	2.0-19.1	50.38
Yellow bullhead	90	3.1-12.7	31.34
Yellow perch	36	3.2-8.6	2.68
Brown bullhead	30	5.4-13.0	13.19
Black crappie	9	6.3-9.1	2.82
Northern pike	5	29.9-34.6	34.50
Walleye	1	20.8	3.85
Other sunfish	107	2.1-7.7	8.22
White sucker	7	13.7-21.5	17.26
Other non-sportfish	24		17.22

also important numerically (9%) and by weight (13%). Northern pike made up 15% of the weight. Altogether, sportfish comprised 97% of the catch and 85% of the weight.

The July DC electrofishing catch rate of bluegills (660/hr) was double the 1987 DC catch rate (348/hr), indicating they are still quite abundant in the lake. The catch rate in June (1,237/hr) was very high. Although bluegills up to 8 inches long were found, the majority were less than 5 inches. The July catch included only 30 bluegills 7-inch or larger while the June catch included only 11. These fish made up just 7% and 1% of the stock-size bluegills.

Bluegill growth remains slow. Age-4 fish averaged 5.2 inches long and age-5 bluegills averaged 6 inches. Bluegills usually average 6 inches long at age-4.

Largemouth bass ranged from 2-19 inches long but the population was dominated by young bass, ages 1-3. Only 19 bass reached or exceeded the 12-inch minimum size limit as bass growth was also slow. Age-4 bass were 10.2 inches long, followed by 12.2 and 13.3 inches at ages 5-6, respectively. Although bass size was small and growth slow, the electrofishing catch rate indicated bass numbers were normal (144/hr).

Several sunfish were collected but were generally small. Redear measured up to 8 inches long but only eight were 7 inch or larger. All but three warmouth were less than 5 inches long and no pumpkinseeds larger than 6 inches were found. Hybrid and green sunfish were collected but nearly all were small.

Other sportfish included 90 yellow bullheads and 30 brown bullheads up to 13 inches long, 36 yellow perch, nine black crappies, five northern pike over 30 inches long and a 21-inch walleye.

Non-sportfish included white suckers, golden shiners, grass pickerel, lake chubsuckers, spotted gar and a spotted sucker and bowfin. No carp were seen.

The survey of fishing activity in June proved fishermen catch mostly 6-7 inch bluegills. Of 46 bluegills caught by five fishing parties, 91% were 7-inches or smaller. Bluegill anglers in boats fished an average of 43 minutes to catch one bluegill.

Although bluegills were small and the catch rate slow, half of the fishermen rated bluegill fishing as "good" and half rated it "fair". However, fishing effort is low. The average number of weekend anglers was 7.2/hr while the average number of weekday anglers was 1.6/hr. These figures expand to 56 fishing hours per acre for the summer months, more than double a 1983 estimate (23 hrs/ac). Typical summer fishing effort at area lakes is 100 hours per acre .

Management Implications

Upper Long Lake's fish community is stable. Despite the reduction in bluegill numbers and two predator stockings; there was little difference between the 1980 and 1991 survey results. The lake continues to be dominated by small, slow-growing bluegills which provide limited fishing opportunity.

Benefits from the single antimycin treatment were short-lived. Whatever conditions led to poor bluegill growth prior to the project are still present. Research is needed to isolate causes of poor bluegill growth in Upper Long Lake or similar natural lakes.

Meanwhile, the 12-inch size limit on largemouth bass imposed in 1990 could boost bass density. Studies show bass size limits also create better bluegill size structure. Therefore, effects of the size limit on bluegills should be monitored at Upper Long Lake.

Submitted by: Jed Pearson
Fisheries Biologist
November 8, 1991

Approved by: Gary Hudson
Gary Hudson
Fisheries Supervisor
November 15, 1991

LAKE SURVEY REPORT

State Form 24753R

Type of survey: ☐ Initial survey ☒ Re-survey

Lake name	County	Date of survey (Month, day, year)
Upper Long Lake	Noble	July 15-17, 1991

Biologist's name	Date of approval (Month, day, year)
Jed Pearson	11/15/91 G.H.

LOCATION

Quadrangle name	Range	Section
Merriam	9E	4, 33

Township name	Nearest town
33N, 34N	Wolf Lake

ACCESSIBILITY

State owned public access site	Privately owned public access site	Other access site
		Ramp owned by Association

Surface acres	Maximum depth	Average depth	Acre feet	Water level	Extreme fluctuations
86	54 Feet	22.1 Feet	1,902	890.92 MSL	None

Location of benchmark: None

INLET

Name	Location	Origin
Unnamed ditch	East side	Runoff

OUTLET

Name	Location
Unnamed ditch	North end, flows to Dollar Lake.

Water level control: Concrete sill dam

POOL	ELEVATION (Feet MSL)	ACRES
TOP OF DAM		
TOP OF FLOOD CONTROL POOL		
TOP OF CONSERVATION POOL		
TOP OF MINIMUM POOL		
STREAMBED		

Bottom type:
- ☐ Boulder
- ☐ Gravel
- ☒ Sand
- ☒ Muck
- ☐ Clay
- ☒ Marl

Watershed use

General agriculture with scattered woodlots.

Development of shoreline

About 2/3 of the shore is residentially developed.

Previous surveys and investigations

Water quality, IDNR, 1972. Fish surveys, IDNR, 1980, 1982-84, 1987.

Antimycin treatment, IDNR, 1981.

SAMPLING EFFORT

ELECTROFISHING	Day hours	Night hours $\frac{1}{4}$ bass, $\frac{1}{2}$ all fish	Total hours 0.75
TRAPS	Number of traps 4	Hours 48	Total hours 192
GILL NETS	Number of nets 3	Hours 48	Total hours 144

PHYSICAL AND CHEMICAL CHARACTERISTICS

Color	Turbidity			
blue-green	8	Feet	6	Inches (SECCHI DISK)

TEMPERATURE

DEPTH FEET	DEGREES F°	DEPTH FEET	DEGREES F°	DEPTH FEET	DEGREES F°
SURFACE	78.0	40	48.5	80	
2	78.0	42	48.0	82	
4	78.0	44	48.0	84	
6	78.0	46	47.5	86	
8	78.0	48	47.5	88	
10	78.0	50	47.0	90	
12	75.0	52	47.0	92	
14	69.5	54		94	
16	62.0	56		96	
18	58.5	58		98	
20	56.5	60		100	
22	55.0	62			
24	54.0	64			
26	53.0	66			
28	52.5	68			
30	52.0	70			
32	51.5	72			
34	51.0	74			
36	51.0	76			
38	50.5	78			

DISSOLVED OXYGEN (D.O.) - TOTAL ALKALINITY - pH

DEPTH FEET	D.O. (ppm)*	ALKALINITY (ppm)*	pH	DEPTH FEET	D.O. (ppm)*	ALKALINITY (ppm)*	pH	Comments:
SURFACE	10.0	171	8.9	45	0.0			Surface TDS: 200
5	10.0			50	0.0	239	8.0	Bottom TDS: 220
10	9.0			55				
15	5.0			60				
20	1.5			65				
25	5.0			70				
30	1.0	faint H_2S smell		75				
35	1.2			80				
40	0.6							

*ppm = parts per million

UPPER LONG LAKE 1991

COMMON SPECIES OF AQUATIC PLANTS

COMMON NAME OF PLANT	SCIENTIFIC NAME OF PLANT	DEPTH FOUND	PERCENT OF LAKE COVERED
Emergents:			
Bulrush	Scirpus spp.	to 2'	rare
Cattail	Typha spp.	to 1'	common
Pickerelweed	Pontederia spp.	to 2'	rare
Spatterdock	Nuphar advena	to 3'	common
Water lily	Nymphaea spp.	to 4'	common
Submergents:			
Chara		to 4'	abundant
Coontail	Ceratophyllum demersum	to 12'	abundant
Sago pondweed	Potamogeton pectinatus	to 8'	rare

Comments

Upper Long Lake has an excellent patchwork distribution of aquatic plants which add to the lake's natural character and fish habitat, including most sections of developed shoreline. No purple loosestrife or curly-leaf pondweed were observed. Milfoil was noted in the 1980 survey but not found in 1991.

Significant wetlands are located along the west and north sides of the lake. These areas should be protected. Plant control should be limited to small areas less than 25 feet wide only along piers and beaches.

UPPER LONG LAKE 1991

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT

*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (Inches)	WEIGHT (Pounds)	PERCENT
Bluegill	529	50.0	1.5 - 7.8	41.57	17.6
Redear	111	10.5	2.2 - 8.4	12.71	5.4
Largemouth bass	109	10.3	2.0 - 19.1	50.38	21.4
Yellow bullhead	90	8.5	3.1 - 12.7	31.34	13.3
Warmouth	40	3.8	2.1 - 7.7	2.49	1.1
Yellow perch	36	3.4	3.2 - 8.6	2.68	1.1
Pumpkinseed	35	3.3	3.2 - 6.2	2.86	1.2
Brown bullhead	30	2.8	5.4 - 13.0	13.19	5.6
Hybrid sunfish	20	1.9	4.0 - 7.4	2.58	1.1
Green sunfish	12	1.1	2.1 - 4.1	0.29	0.1
Black crappie	9	0.9	6.3 - 9.1	2.82	1.2
White sucker	7	0.7	13.7 - 21.5	17.26	7.3
Golden shiner	7	0.7	2.0 - 8.6	.56	0.2
Grass pickerel	6	0.6	6.5 - 13.0	1.66	0.7
Northern pike	5	0.5	29.9 - 34.6	34.50	14.6
Lake chubsucker	5	0.5	9.2 - 10.5	2.48	1.1
Spotted gar	4	0.4	12.5 - 31.1	9.56	4.1
Walleye	1	0.1	20.8	3.85	1.6
Spotted sucker	1	0.1	17.5	2.36	1.0
Bowfin	1	0.1	12.0	.60	0.3
	1,058			235.74	

*Common names of fishes recognized by the American Fisheries Society

UPPER LONG LAKE 1991

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF: *(species)* BLUEGILL

TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH	TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH
1.0					14.5				
1.5	1	0.2	.01		15.0				
2.0	15	2.8	.02		15.5				
2.5	74	14.0	.02		16.0				
3.0	14	2.6	.03		16.5				
3.5	48	9.1	.02		17.0				
4.0	60	11.3	.04		17.5				
4.5	67	12.7	.05		18.0				
5.0	53	10.0	.07		18.5				
5.5	61	11.5	.11		19.0				
6.0	57	10.8	.13		19.5				
6.5	49	9.3	.17		20.0				
7.0	25	4.7	.22		Total	529			
7.5	4	0.8	.23						
8.0	1	0.2	2.7						
8.5									
9.0									
9.5									
10.0									
10.5									
11.0									
11.5									
12.0									
12.5									
13.0									
13.5									
14.0									

ELECTROFISHING CATCH	330	GILL NET CATCH	116	TRAP NET CATCH	83

UPPER LONG LAKE 1991

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF: *(species)* BLUEGILL (June electrofishing catch)

TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH	TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH
1.0					14.5				
1.5	8	0.9	.01	I+	15.0				
2.0	67	7.2	.02	I+	15.5				
2.5	40	4.3	.02	I+, II+	16.0				
3.0	63	6.8	.03	II+	16.5				
3.5	103	11.1	.03	II+,III+	17.0				
4.0	189	20.4	.04	III+	17.5				
4.5	160	17.2	.05	III+,IV+	18.0				
5.0	79	8.5	.08	III+, IV+, VI+	18.5				
5.5	97	10.5	.10	IV+	19.0				
6.0	72	7.8	.13	IV+,VI+	19.5				
6.5	39	4.2	.17	V+, VI+	20.0				
7.0	7	0.8	.21	IV+, V+, VI+					
7.5	4	0.4	.27	IV+, V+, VIII+					
8.0									
8.5									
9.0									
9.5									
10.0									
10.5									
11.0									
11.5									
12.0									
12.5									
13.0									
13.5									
14.0									

ELECTROFISHING CATCH		GILL NET CATCH		TRAP NET CATCH	

UPPER LONG LAKE 1991

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF: *(species)* LARGEMOUTH BASS

TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH	TOTAL LENGTH *(Inches)*	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT *(Pounds)*	AGE OF FISH
1.0					14.5	1	1.0	1.58	VI+
1.5					15.0	1	1.0	1.68	VII+
2.0	1	1.0	.02	0+	15.5	1	1.0	1.88	VII+
2.5	3	2.8	.02	0+	16.0				
3.0					16.5				
3.5					17.0				
4.0	1	1.0	.02	I+	17.5	1	1.0	3.23	
4.5	10	9.2	.04	I+	18.0				
5.0	9	8.3	.06	I+	18.5				
5.5	3	2.8	.08	I+	19.0	1	1.0	3.86	
6.0	1	1.0	.10	I+	19.5				
6.5	5	4.6	.12	II+	20.0				
7.0	9	8.3	.16	II+	Total	109			
7.5	10	9.2	.19	II+					
8.0	3	2.8	.21	II+					
8.5	5	4.6	.29	II+,III+					
9.0	7	6.4	.35	II+,III+					
9.5	6	5.5	.39	III+,IV+					
10.0	4	3.7	.46	III+					
10.5	6	5.5	.55	III+,IV+					
11.0	4	3.7	.65	IV+					
11.5	3	2.8	.64	IV+					
12.0	2	1.8	.83	IV+					
12.5	4	3.7	.93	V+,VI+					
13.0									
13.5	2	1.8	1.32	V+					
14.0	6	5.5	1.38	V+, VI+					

ELECTROFISHING CATCH	108	GILL NET CATCH	1	TRAP NET CATCH	0

UPPER LONG LAKE 1991

Species: BLUEGILL

0.8" intercept (based on June collection)

YEAR CLASS	NUMBER OF FISH AGED	BACK CALCULATED LENGTH *(Inches)* AT EACH AGE					
		I	II	III	IV	V	VI
1990	12	1.6					
1989	10	1.5	2.5				
1988	12	1.7	2.6	3.6			
1987	17	1.7	3.0	4.2	5.4		
1986	6	1.7	2.7	4.2	5.7	6.4	
1985	5	1.4	2.3	3.3	4.5	5.5	6.1
AVERAGE LENGTH		1.6	2.6	3.8	5.2	6.0	6.1
NUMBER AGED		62	50	40	28	11	5

Species: LARGEMOUTH BASS

0.8" intercept

YEAR CLASS	NUMBER OF FISH AGED	BACK CALCULATED LENGTH *(Inches)* AT EACH AGE					
		I	II	III	IV	V	VI
1990	14	2.6					
1989	21	2.3	4.8				
1988	19	2.7	5.5	7.6			
1987	9	2.4	5.7	7.9	9.6		
1986	5	2.7	6.0	8.2	10.8	12.3	
1985	5	2.5	5.6	8.6	10.2	12.0	13.2
AVERAGE LENGTH		2.5	5.5	8.1	10.2	12.2	13.2
NUMBER AGED		73	59	38	19	10	5

Species:

YEAR CLASS	NUMBER OF FISH AGED	BACK CALCULATED LENGTH *(Inches)* AT EACH AGE					
		I	II	III	IV	V	VI
AVERAGE LENGTH							
NUMBER AGED							

Species:

YEAR CLASS	NUMBER OF FISH AGED	BACK CALCULATED LENGTH *(Inches)* AT EACH AGE					
		I	II	III	IV	V	VI
AVERAGE LENGTH							
NUMBER AGED							

NOTE: *If not included in average length calculations indicate with a (*)*

Lower Long Lake
NOBLE COUNTY
FISH POPULATION SURVEY
1992

INDIANA DIVISION OF
FISH & WILDLIFE

BACKGROUND

Lower Long Lake is a 66-acre natural lake located 4 miles west of Albion off County Road 200N. Public access is available at a county-owned easement on the north shore. However, parking space is limited.

Maximum depth of Lower Long Lake is 55 feet. Average depth is 24 feet. It holds 507 million gallons. Water level is controlled at an elevation of 889.81 feet by a concrete sill. The outlet flows to the Elkhart River. The largest inlet enters the south end of the lake, draining Pleasant, Upper Long and Dollar Lakes. A smaller inlet enters the west side and drains Bowman and Russell Lakes. The total drainage area is 2,784 acres and the average water retention time is 200 days.

Water clarity is good. Secchi disc readings have varied from 11.5 feet in August 1972 to 8.9 feet in August 1989 and 12 feet in June 1992. During summer, enough oxygen is present for fish down to 7.5-20 feet (>5ppm) where temperatures are 50-60F. The lake's trophic index is 20, indicating it ranks high in water quality.

The lake bottom is mostly muck and sand. Significant wetlands are located on the south and west shores. Arrow arum, bulrushes and lilies are common along the shore. Spatterdock grows at the mouth of the inlet on the south shore and near the outlet. Milfoil is the most abundant submergent plant and encircles much of the shoreline. Coontail is also common.

Eight homes were built at the lake by the early 1950s. Two subdivisions at the north and south ends are now undergoing development. A 6-acre wetland along the west side is owned by the local Soil and Water Conservation District.

A fish population survey was conducted on June 1-3, 1992 to obtain information on the status of the fish community. No previous fishery information was available, although local anglers said bluegill fishing was good. Sampling effort consisted 45 minutes of electrofishing, six gill net lifts and eight trap net lifts.

RESULTS

During the survey, 623 fish weighing 287 pounds were collected. Nineteen species were represented. Bluegills (48%), largemouth bass (23%) and redear (10%) dominated the catch. Bass also comprised most of the weight, followed by northern pike (20%), bluegills (10%) and carp (10%). Sportfish accounted for 93% of the catch and 75% of the weight.

Bluegills measured up to 8.6 inches long. As many as 17% of the stock-size bluegills (>3-in) were catchable-size (>7-in). The electrofishing catch rate (268/hr) and trap net catch rate (7/lift) were low. Bluegill weights and growth were average, with fish reaching 6 inches long by age-4.

The largest bass was 22.5 inches long and weighed 6 pounds. Legal-size bass (>12-in) made up 44% of the catch of stock-size bass (>8-in). The electrofishing catch rate (192/hr) was high. Bass weights were normal for fish up to 13 inches long but below normal for larger fish. Their growth rate was average however, with bass reaching legal-size between ages 4 and 5.

Redear measured 4-8 inches long, but most (68%) were 6-7 inches long. Their weights were average but their growth was slow. Age-4 redear averaged less than 6 inches long.

Fifteen northern pike were caught during the survey. All but one was legal-size (>20-in). The largest was 33.5 inches long and weighed nearly 11 pounds. Pike weights were above average and their growth was average. They typically reached 20 inches by age-3.

Other sportfish included several sunfish (warmouth, pumpkinseeds and rock bass), yellow perch up to 11 inches long, yellow and brown bullheads, and black crappies up to 12 inches long.

Nonsport fish in the catch included 10 white suckers from 12-21 inches long, brook silversides, spotted suckers, spotted gar up to 21 inches long, bowfin, lake chubsuckers, grass pickerel and two carp up to 35 inches long. The largest carp weighed 22 pounds.

Table 1. Number, size and weight of fish collected at Lower Long Lake, June 1-3, 1992.

Species	Number	Inches	Pounds
Bluegill	296	1.4-8.6	29.65
Largemouth bass	146	2.8-22.4	94.19
Redear	65	4.0-8.0	12.41
Warmouth	17	3.9-7.2	2.50
Northern pike	15	19.5-33.5	56.00
Yellow bullhead	12	8.2-11.0	6.76
White sucker	10	12.0-20.6	19.03
Yellow perch	10	5.8-11.3	2.92
Brook silverside	8	3.2-3.7	0.05
Spotted sucker	7	10.4-15.1	5.94
Black crappie	7	7.0-12.3	4.07
Spotted gar	6	11.5-21.3	3.84
Pumpkinseed	6	2.0-6.0	0.66
Brown bullhead	5	10.3-13.8	5.84
Bowfin	4	12.9-25.7	12.39
Lake chubsucker	4	5.3-8.1	0.58
Carp	2	23.8-35.0	29.56
Grass pickerel	2	7.1-11.3	0.38
Rock bass	1	9.0	0.59
TOTAL	623		287.36

MANAGEMENT IMPLICATIONS

Lower Long Lake presently contains a satisfactory fish population. Ample numbers of catchable-size bluegills, largemouth bass and northern pike are available to fishermen. Other sportfish add diversity to the catch. Nonsport fish are not abundant.

Although bluegills are not abundant, they grow much faster in Lower Long Lake than they do in nearby Upper Long Lake (Figure 1), even though Lower Long Lake is apparently less productive. Lower Long Lake's trophic index (20) is 12 points less than Upper Long Lake (32). Yet age-4 bluegills are nearly 1 inch larger in Lower Long Lake. As a result, there are more catchable-size bluegills (Figure 2).

Better growth of bluegills may indicate Lower Long Lake has more predator fish that feed on small bluegills. For example, the electrofishing catch rate of largemouth bass was 33% higher in Lower Long Lake than Upper Long Lake. More than twice as many legal-size bass were collected at Lower Long Lake (52) than Upper Long Lake (19). Three times as many northern pike were also collected in Lower Long Lake. Predator fish may be reducing the total number of bluegills in the lake but allowing those which survive to find more food and grow faster.

Subtle differences in fish habitat, e.g. aquatic plant density, may also be allowing bluegills to grow faster in Lower Long Lake. Chara is much more dense in Upper Long Lake and may provide too much escape cover for small fish. Although milfoil is abundant in Lower Long Lake, it apparently does not interfere with the ability of predator fish to capture prey.

RECOMMENDATIONS

The most immediate need at Lower Long Lake is to improve public access. The present county-owned easement on the north shore does not offer adequate parking space for several vehicles with trailers. The launching area does not have enough turn-around space. The unimproved dirt ramp is deeply rutted. Other locations around the shore may be better suited for public access. It is recommended that efforts be made to acquire a larger site for public access development.

Long-term management at Lower Long Lake should focus on protecting fish habitat and maintaining a dense predator fish population. Conservation programs to reduce nutrient and sediment inputs to the lake should be supported. Significant wetlands located at the mouth of the inlet and along the west side of the lake should be protected. Shoreline alterations, such as beaches and seawalls, should be minimized. Lake residents should develop a community beach to offset requests for habitat alterations at numerous individual beaches. Although aquatic plant control could be permitted around piers and beaches, a large-scale weed control program is not needed.

To protect largemouth bass populations throughout northern Indiana, a 12-inch minimum size limit went into effect in 1991. This limit should help maintain Lower Long Lake's bass population as fishing pressure increases, so long as fishermen comply with the rule.

No additional management programs are needed at this time.

Sumitted by: Jed Pearson
November 10, 1992

Approved by: Gary Hudson
Gary Hudson
Fisheries Supervisor
November 12, 1992

REFERENCES

Pearson, J. 1991. Upper Long Lake fish population survey. Indiana Department of Natural Resources.

Taylor, M. 1972. Lower Long Lake water quality check. Indiana Department of Natural Resources.

Figure 1. Average length of bluegills at ages 1-6 at Lower Long Lake and Upper long Lake.

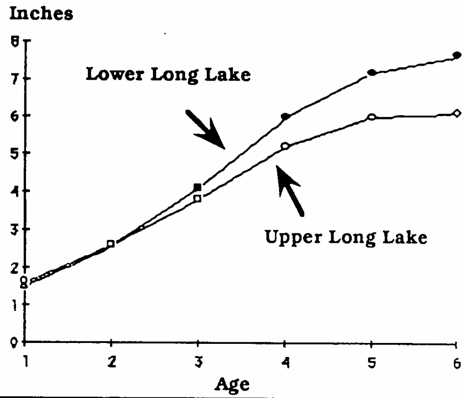
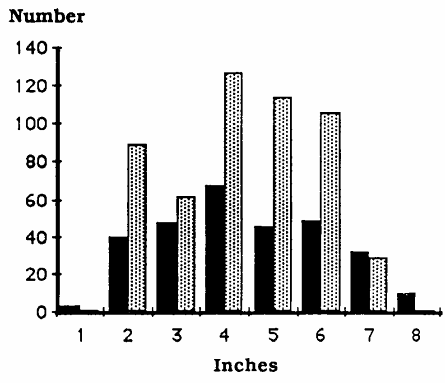


Figure 2. Number and size of bluegills collected at Lower Long Lake (dark columns) and Upper Long Lake (light columns).



Upper Long Lake
NOBLE COUNTY
FISH MANAGEMENT REPORT
1995

Department of Natural Resources — Division of Fish and Wildlife

BACKGROUND

Upper Long Lake is an 86-acre natural lake located near the town of Wolf Lake in southwestern Noble County. It lies at the headwaters of a tributary to the Elkhart River South Branch. Over half of the shoreline is residential and much of the watershed is agricultural.

Maximum depth of Upper Long Lake is 54 feet and average depth is 22 feet. The lake is relatively clear (8-11 ft secchi readings). Water quality is also good and has changed little over the past two decades. The lake's trophic index was listed at 32 in the 1970s and late 1980s. During summer, trace amounts of oxygen are present down to 40 feet. Adequate amounts (≥5 ppm) are present down to 15 feet and again at 25 feet. The lake thermally stratifies at 10-18 feet where temperatures drop from 75F to 58F.

The bottom consists of sand and marl. Nearly all shallow shoreline areas are covered with chara. Coontail is also abundant in deeper offshore areas. The dominant emergent plants are cattails and lilies interspersed along most of the shore.

In 1995, the Department of Natural Resources acquired lakefront property for development of a public access site. A concrete boat ramp and gravel parking area will be constructed at the northern end of the lake. Because the lake will be more accessible, the DNR's Division of Fish and Wildlife intends to place renewed emphasis on management its fish community.

MANAGEMENT HISTORY

The first fish population survey at Upper Long Lake was conducted in 1980. At the time, slow-growing bluegills and other small panfish were present. Less than 10% of the adult bluegills (≥3-in) were 6-inch or larger. Less than 2% were 7-inch or larger. Bluegills required as many as six years to reach 6 inches long.

To reduce the density of small panfish and improve bluegill growth, 13 units of Fintrol® concentrate with 10% active ingredient (antimycin) were applied to the lake at a rate of 0.7 ppb in 1981. After the treatment, 10,300 largemouth bass fingerlings and 912 adult bass were restocked.

Annual surveys from 1982-84 indicated bluegill numbers were reduced. The electrofishing catch rate of bluegills decreased 95%. Age-3 bluegills were 2 inches larger in 1983 compared to 1980, while age-4 fish were 1 inch larger. However, these improvements did not last.

By 1984, the electrofishing catch rate increased 42% higher than it was prior to the project. By 1987, age-3 and age-4 bluegills were growing slowly again. Small bluegills dominated the fish community despite the larger bass population.

To boost the number of predator fish and provide additional fishing opportunity, local residents stocked 1,000 walleye fingerlings in 1986. None were found during the 1987 survey and only one, a 21-inch walleye, was found during a follow-up survey in 1991. A 12-inch minimum size limt was also placed on largemouth bass in 1990.

During the 1991 survey, bluegills made up 50% of the catch by number and 18% of the weight, but fewer than 7% of the adult bluegills were 7-inch or larger. Redear and largemouth bass acccounted for 10% of the catch and bass ranked first in weight (21%). Although bass up to 19 inches long were sampled, their growth was also slow. Five northern pike over 30 inches long were also caught. A survey of fishing activity in June 1991 documented anglers catch mostly 6- to 7-inch bluegills.

To obtain more-detailed information on the status of largemouth bass and bluegill populations in Upper Long Lake and to assess the feasibility of improving the fish community, additional sampling was conducted in 1995. During April and May, largemouth bass population density and size were estimated based on mark-recapture techniques. Bluegills were electrofished on two occasions in June. The results of this sampling are presented in this report.

CURRENT STATUS

Based on sampling in April and May, numbers and sizes of largemouth bass in Upper Long Lake are similar to many lakes in the area. The mean nightly electrofishing catch rate of 8-inch and larger bass was 101 per hour, compared to 96 per hour for most natural lakes. Catch rates of all size groups of bass less than 18 inches long were within 6% of the mean of all natural lakes, while the catch rate of 18-inch and larger bass was 63% greater than the area mean (Figure 1). The actual number of 8-inch and larger bass in Upper Long Lake was estimated to be 1,067 (SE=112). Density was 12.4 bass per acre and was within 21% of the mean for natural lakes. Densities of bass larger than 12 inches were within 15% of the area mean (Figure 2).

Figure 1. *Electrofishing catch rate (N/hour) of four size groups of largemouth bass at Upper Long Lake (light columns) compared to other area lakes (dark columns).*

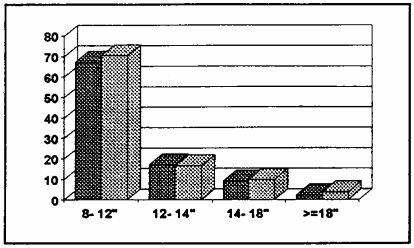
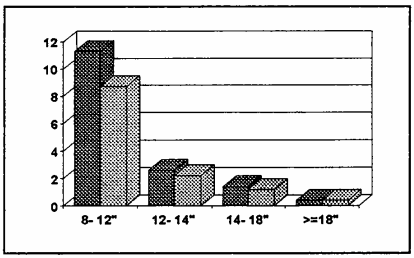


Figure 2. *Density (N/acre) of four size groups of largemouth bass in Upper Long Lake (light columns) compared to other area lakes (dark columns).*



Bass growth remains slow in Upper Long Lake in compaison to other lakes in the area (Figure 3). They average 1.3 inches shorter at each age through age-6. At age-4 they are only 10.4 inches long, compared to 11.7 inches in most lakes. At age-6 they are only 14.2 inches long, compared to 15.4 inches in most lakes.

During Jūne sampling, 1,541 bluegills were collected on two nights, including 1,426 that were less than 6 inches long (Figure 4). Only 29 were 7-inch or larger and none were 8-inch or larger. The overall catch rate rate was 1,027 per electrofishing hour and was double the mean for natural lakes. The catch rate of bluegills less than 3 inches long (347/hr) was three times the normal rate while the catch rate of 7-inch bluegills (19/hr) was about half the normal rate for most lakes.

Small fish comprise an unusually high percentage of the bluegill population in Upper Long Lake compared to other lakes in the area (Figure 5). Normally 3- to 6-inch

Figure 3. *Growth (inches) of age-1 through age-6 largemouth bass in Upper Long Lake (light columns) compared to other area lakes (dark columns).*

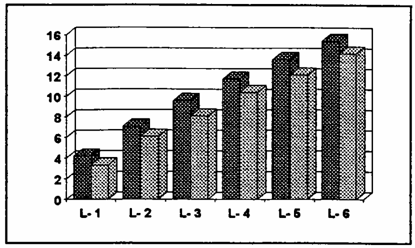


Figure 4. *Electrofishing catch rate (N/hour) of five size groups of bluegills at Upper Long Lake (light columns) compared to other area lakes (dark columns).*

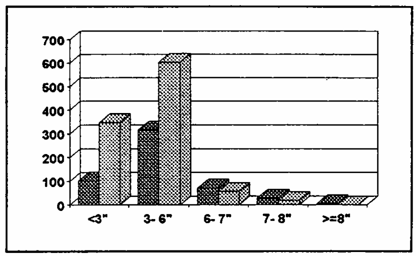
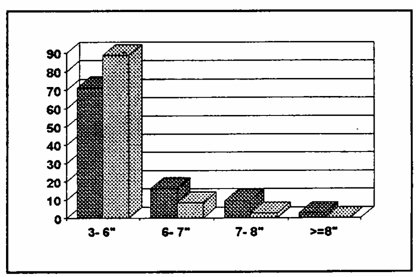


Figure 5. *Percentages of four size groups of bluegills in Upper Long Lake (light columns) compared to other area lakes (dark columns).*



fish make up 71% of the population of adult bluegills ($\geq$3-in) in most lakes. At Upper Long Lake they comprise 89%. Bluegills large enough to interest most fishermen ($\geq$7-in) typically comprise 12% of the population in most lakes but comprise less than 3% in Upper Long.

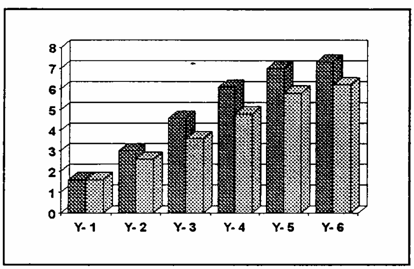
Bluegill growth is normal for age-1 fish, slow for age-2 fish and very slow for older fish (Figure 6). In most lakes, bluegills reach 6.1 inches long by age-4 but in Upper Long Lake they average only 4.8 inches. Even by age-6 they average only 6.2 inches long.

MANAGEMENT IMPLICATIONS

Upper Long Lake continues to be dominated by small, slow-growing bluegills. Few bluegills large enough to interest anglers are present. Bass growth is also slow. Although bass numbers are comparable to other lakes in the area, they are apparently unable to prey on enough small bluegills to maintain good bluegill growth. With numbers of small bluegills as high as they are, bass should grow faster. They too must be having difficulty finding or capturing adequate food.

For decades biologists have tried to determine the causes of poor bluegill size and growth in natural lake communities similar to Upper Long Lake. They have focused on morphoedaphic factors (basin shape, water chemistry and fertility), zooplankton density and size, aquatic plant biomass and stem density, predator-prey dynamics, angling pressure, genetic selection, and more recently, early-maturation energy consumption. To date, no one has adequately identified the major causes of poor bluegill quality in natural lake fish communities. As a result, few management options are available or have proven successful for improving bluegill fishing. In some cases such as Upper Long's, it may simply be better to abandon any effort to improve bluegill fishing and concentrate greater effort toward providing fishing opportunities for alternative species.

Figure 6. *Growth (inches) of age-1 through age-6 bluegills in Upper Long Lake (light columns) compared to other area lakes (dark columns).*



Local residents have expressed interest in stocking fish in Upper Long Lake. While some believe stocking a predatory species will improve bluegill fishing, stockings at other lakes in the area have had little effect on the existing fish community. At nearby Skinner Lake where hybrid muskies were stocked at four times the normal density, they did little to improve bluegill fishing.

Potential species for stocking ought to be those fish currently not present in Upper Long Lake in order to add greater diversity to the fish community. For example, there are adequate numbers and sizes of largemouth bass. Simply stocking more bass when those present are already growing slowly would do little to improve fishing. On the other hand, smallmouth bass are popular among many anglers and are not common in Indiana natural lakes, but whether they can find a niche in Upper Long Lake is not known. Walleyes are also popular with anglers and more could be stocked in the lake. The 1986 stocking may not have succeeded simply because too few fish were released. The fact that one walleye reached 21 inches long indicates there may be some potential for good walleye growth.

Other candidates for stocking include channel catfish, muskies and trout, but these species are less popular than smallmouth bass and walleyes. Since bullheads and northern pike are already present, anglers may have little desire for catfish or muskies. Trout have a narrow tolerance of environmental conditions and require cold water with plenty of oxygen to survive and grow. Water quality in Upper Long Lake could be adequate to support trout only during certain years. In addition, most trout caught by anglers are usually taken immediately after stocking and do not provide much fishing during the rest of the year. They also seldom live for more than three years in most lakes. Therefore, it is recommended that attempts be made at Upper Long Lake to provide greater fishing diversity by stocking either smallmouth bass or more walleyes.

Submitted by: Jed Pearson, fisheries biologist
March 12, 1996

Approved by: Gary Hudson
Gary Hudson, fisheries supervisor
March 13, 1996

Approved by: Bill James
Bill James, chief of fisheries
March 20, 1996

APPENDIX H

LAB ANALYSES FOR BACTERIA, NITROGEN, & PHOSPHORUS

LaPorte County Health Department Water Laboratory
4th Floor, Courthouse Square, LaPorte IN 46350

005723 | 10-5-92
Lab No. | Date Rec.
11:30pm
Time Rec. | Name

SAMPLE DATA
(To Be Completed By Client)
PLEASE read instructions on back.

Examination Results Should Be Sent To:

Name: Environmental Testing

Street: 204 2nd St

City or Town: LaPorte INDIANA 46350 Zip Code

PWS/POOL ID# [| | | | | | |]

D R O [| |]

Name of Organization: Environmental Testing

City or Town: Upper Long Lake

County: Noble Phone: 324-9939

Superintendent: ______

Collected By: Mike Gensic

Sampling Address: Upper Long Lake

Which Tap: ______

Chlorine Residual: ______

TYPE OF SAMPLE (check appropriate space)

____ Well water
____ Swimming Pool
____ Whirlpool/Spa
____ Bathing Beach
✓ Surface Water
____ Swabs
____ Other ______

DATE

Mo.	Day	Yr.
10	5	92

TIME 7:45 AM/PM (AM circled)

Tests Requested: Escherichia coli

An Additional Copy of Results Should Be Sent To:

Name: Environmental Testing

Street: As above

City or Town ______ INDIANA ______ Zip Code

ANALYSIS DATA
(To Be Completed By Lab)

TEST PERFORMED:

____ Total Coliform ____ Fecal Coliform ____ HPC
____ Nitrate X Escherichia Coli ____ ____

	RESULT		VERIFIED
BATHING BEACH, SURFACE WATER: E. COLI	0.1 ml	0	2
	1.0 ml	0	
	10 ml	0	
	100 ml	2	

DRINKING WATER:
TOTAL COLIFORM
NITRATE mg/L

POOLS:
HPC cfu/ml:
TOTAL COLIFORM
FECAL COLIFORM

(NOTE: Unless Specified, Results are cfu/100 ml.)

REPORT OF SAMPLE:

X SATISFACTORY
____ QUESTIONABLE
____ UNSATISFACTORY

____ Submit two check samples from this same sampling point. (One each on two consecutive days during open lab hours.)

____ Submit four check samples from sampling points both upstream and downstream of this sampling point.

____ NOT VALID BECAUSE:

____ There was too long a time between collection of sample and receipt for examination.
____ The water sample contained Chlorine residual.
____ There was an overgrowth in the MF test.
____ Other: ______
____ WE ADVISE THAT ANOTHER SAMPLE BE SUBMITTED.

LAB ID

M 4 6 - 3

ANALYSED BY: DJS

TIME AND DATE: 10-5-92 4

American Analytical Inc.

Environmental and Industrial
Analytical Laboratory Services

7870 Broadway
Merrillville, IN 46410
Tel: 219-769-8378
Fax: 219-769-1664

September 29, 1992

Mr. Joe Camp
ETLC, Inc.
204 2nd Street
LaPorte, Indiana 46350

RE: Upper Long Lake

Dear Mr. Camp:

Enclosed are the Total Phosphate, Ortho Phosphate, TKN, Nitrate and Ammonia as N results for the soil and water samples that we received from you on August 31, 1992.

Enclosed you will find all Quality Control associated with these samples. Also, we will keep a copy of all Quality Control on file for your convenience for five years. After such time it will be disposed if we are not otherwise notified.

It has been a pleasure serving you; and if you have any questions concerning these results please do not hesitate to contact us.

Respectfully Submitted,

American Analytical, Inc.

John S. Sima
Laboratory Director

JSS/ces

Enclosures

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client: ETLC, Inc.

Analyte: Ammonia as N
Sample Matix: Water
Date Sampled: 08/30/92
Date Received: 08/31/92
Date Analyzed: 09/17/92
Analyst: MZ
Project Identification: Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/L)	QUANTITATION (mg/L)
924255	3 ft #1	0.10	0.10
924256	3 ft #2	0.11	0.10
924257	42 ft #1	1.14	0.10
924258	42 ft #2	1.11	0.10
924510	TB-4	<0.10	0.10

Analyte Method: U.S. EPA 600/4-79-020 350.2

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client: ETLC, Inc.

Analyte: Nitrate
Sample Matix: Water
Date Sampled: 08/30/92
Date Received: 08/31/92
Date Analyzed: 09/22/92
Analyst: MZ
Project Identification: Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/L)	QUANTITATION (mg/L)
924251	3 ft #1	<0.10	0.10
924252	3 ft #2	<0.10	0.10
924253	42 ft #1	<0.10	0.10
924254	42 ft #2	<0.10	0.10
924509	TB-3	<0.10	0.10

Analyte Method: U.S. EPA 600/4-79-020 352.1

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client:	ETLC, Inc.
Analyte:	TKN
Sample Matix:	Soil
Date Sampled:	08/30/92
Date Received:	08/31/92
Date Digested:	09/17/92
Date Analyzed:	09/21/92
Analyst:	MZ
Project Identification:	Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/Kg)	QUANTITATION (mg/Kg)
924249	Bottom Sediment #1	741	4.87
924250	Bottom Sediment #2	637	4.75

Analyte Method: U.S. EPA 600/4-79-020 351.3
(Modified for soils)

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client: ETLC, Inc.

Analyte: TKN
Sample Matix: Water
Date Sampled: 08/30/92
Date Received: 08/31/92
Date Digested: 09/17, 21/92
Date Analyzed: 09/17, 21/92
Analyst: MZ
Project Identification: Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/L)	QUANTITATION (mg/L)
924255	3 ft #1	0.54	0.10
924256	3 ft #2	0.58	0.10
924257	42 ft #1	1.81	0.10
924258	42 ft #2	1.69	0.10
924511	TB-5	<0.10	0.10

Analyte Method: U.S. EPA 600/4-79-020 351.3

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client: ETLC, Inc.

Analyte: Total Phosphate
Sample Matix: Soil
Date Sampled: 08/30/92
Date Received: 08/31/92
Date Digested: 09/18/92
Date Analyzed: 09/18/92
Analyst: MZ
Project Identification: Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/Kg)	QUANTITATION (mg/Kg)
924249	Bottom Sediment #1	<2.02	2.02
924250	Bottom Sediment #2	<2.21	2.21

Analyte Method: U.S. EPA 600/4-79-020 365.2
(Modified for soils)

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client: ETLC, Inc.

Analyte: Total Phosphate
Sample Matix: Water
Date Sampled: 08/30/92
Date Received: 08/31/92
Date Digested: 09/18/92
Date Analyzed: 09/18/92
Analyst: MZ
Project Identification: Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/L)	QUANTITATION (mg/L)
924245	3 ft #1	<0.05	0.05
924246	3 ft #2	<0.05	0.05
924247	42 ft #1	0.40	0.05
924248	42 ft #2	0.40	0.05
924508	TB-2	<0.05	0.05

Analyte Method: U.S. EPA 600/4-79-020 365.2

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

American Analytical Inc.

7870 Broadway
Merrillville, IN. 46410
Tele: 219-769-8378
Fax: 219-769-1664

WET CHEMISTRY
ANALYTICAL RESULTS

Client:	ETLC, Inc.
Analyte:	Ortho Phosphate
Sample Matix:	Water
Date Sampled:	08/30/92
Date Received:	08/31/92
Date Analyzed:	09/15/92
Analyst:	MZ
Project Identification:	Upper Long Lake

LABORATORY NUMBERS	SAMPLE IDENTIFICATION	CONCENTRATION (mg/L)	QUANTITATION (mg/L)
924245	3 ft #1	<0.05	0.05
924246	3 ft #2	<0.05	0.05
924247	42 ft #1	0.45	0.05
924248	42 ft #2	0.44	0.05
924507	TB-1	<0.05	0.05

Analyte Method: U.S. EPA 600/4-79-020 365.2

Respectfully Submitted,
American Analytical, Inc.

Laboratory Director

DUPLICATES

	Sample (S)	*Sample Duplicate (SD)*	*Relative Percent Difference (RPD)*
Ortho Phosphate	-0.03	-0.04	0
Total Phosphate	0.02	0.02	0
TKN	0.54	0.58	7.14
Ammonia as N	0.10	0.10	0
Nitrate	0.05	0.05	0

$$\text{RPD} = \frac{(S - D)}{[(S + D)/2]} \times 100$$

SPIKE SAMPLE RECOVERY

	Sample (S)	*Spiked Sample (SS)*	*Spike Added (SA)*	*% Recovery*
Ortho Phosphate	-0.03	0.24	0.25	96.0
Total Phosphate	0.02	0.29	0.25	108
TKN	0.50	1.40	1.00	90.0
Ammonia as N	0.10	1.14	1.00	104
Nitrate	0.05	1.12	1.00	107

% Recovery = SS - S / SA x 100

LAB CONTROL STANDARD

	True Value (mg/L)	*Experimental Value (mg/L)*	*% Recovery*
Ortho Phosphate	-0.03	0.25	96.0
Total Phosphate	0.02	0.25	108
TKN	0.50	1.00	90.0
Ammonia as N	0.10	1.00	104
Nitrate	0.05	1.00	107

BLANKS (mg/L)

Ortho Phophate	-0.01
Total Phophate	0.00
TKN	0.21, 0.18
Ammonia as N	0.00
Nitrate	0.01

ANALYSIS FOR NITRATE

Sample	*Initial Absorbance*	*Final Absorbance*	*Absorbance of Analyte*	*Concentration (mg/L)*
Blank	0.000	0.048	0.048	0.01
Standard	0.000	0.198	0.198	1.02 (102%)
924251	0.015	0.068	0.053	0.05
924251 Dup	0.012	0.065	0.053	0.05
924251 Spike	0.013	0.226	0.213	1.12 (107%)
924252	0.010	0.058	0.048	0.01
924253	0.053	0.102	0.049	0.02
924254	0.049	0.094	0.045	0.00
924509	0.000	0.046	0.046	0.00

ANALYSIS FOR TKN-NITROGEN

Sample	*Initial Absorbance*	*Final Absorbance*	*Absorbance of Analyte*	*Concentration (mg/L)*	*Concentration Corrected*
PBW 0915 (prep blank water)	0.000	0.157	0.157	0.21	
LCSW 0915 (lab control standard wtr)	0.000	0.498	0.498	1.20	0.99 (99%)
924255	0.000	0.249	0.249	0.48	0.54 (mg/L)
924255 Dup	0.000	0.255	0.255	0.50	0.58 (mg/L)
924256	0.000	0.257	0.257	0.50	0.58 (mg/L)
924256 Spike	0.000	0.566	0.566	1.40 (90%)	
PBB 0917	0.000	0.147	0.147	0.18	
924257	0.000	0.766	0.766	1.99	1.81 (mg/L)
924258	0.000	0.726	0.726	1.87	1.69 (mg/L)
924249 (1 - 10)	0.000	0.668	0.668	1.70 = 17.0	741 (mg/Kg)
924250 (1 - 10)	0.000	0.606	0.606	1.52 = 15.2	637 (mg/Kg)
924511	0.000	0.154	0.154	0.20	0.02

CALCULATIONS

$$\text{mg/L} = (A - B) \times \frac{C}{D}$$

A = Concentration from calibration curve
B = Concentration of prep blank
C = Volume of sample digested in liter
D = Final volume after digestion and distillation

$$\text{mg/Kg} = (A - B) \times \frac{C}{D}$$

A = Concentration from calibration curve
B = Concentration of prep blank
C = Volume of sample digested in liter
D = Mass of sample used for digestion in kilograms

ANALYSIS FOR AMMONIA-NITROGEN

Sample	*Initial Absorbance*	*Final Absorbance*	*Absorbance of Analyte*	*Concentration (mg/L)*
Blank	0.000	0.085	0.085	0.00
Standard	0.000	0.450	0.450	1.06 (106%)
924255	0.000	0.118	0.118	0.10
924255 Dup	0.000	0.117	0.117	0.10
924255 Spike	0.000	0.476	0.476	1.14 (104%)
924256	0.000	0.122	0.122	0.11
924257	0.000	0.474	0.474	1.14
924258	0.000	0.464	0.464	1.11
924511	0.000	0.103	0.103	0.05

ANALYSIS FOR ORTHO PHOSPHATE

Sample	*Initial Absorbance*	*Final Absorbance*	*Absorbance of Analyte*	*Concentration (mg/L)*
Blank	0.000	0.005	0.005	-0.01
Standard	0.002	0.318	0.316	0.27
924245	0.032	0.016	-0.016	-0.03
924245 Dup	0.034	0.016	-0.018	-0.04
924245 Spike	0.033	0.319	0.286	0.24
924246	0.034	0.013	-0.021	-0.04
924247	0.011	0.520	0.509	0.45
924548	0.016	0.510	0.494	0.44
924507	0.000	0.005	0.005	-0.01

ANALYSIS FOR TOTAL PHOSPHATE

Sample	*Initial Absorbance*	*Final Absorbance*	*Absorbance of Analyte*	*Concentration (mg/L)*
PBW 0918 (prep blank water)	0.000	0.014	0.014	0.00
LCSW 0918 (lab control standard wtr)	0.000	0.316	0.316	0.27 (108%)
924508	0.000	0.015	0.015	0.00
924245	0.000	0.033	0.033	0.02
924245 Dup	0.000	0.035	0.035	0.02
924245 Spike	0.000	0.331	0.331	0.29 (108%)
924246	0.000	0.037	0.037	0.02
924247	0.000	0.450	0.450	0.40
924248	0.000	0.452	0.452	0.40
924249	0.000	0.031	0.031	0.01
924250	0.000	0.024	0.024	0.00

CALCULATION FOR SOIL

$$\text{mg/Kg Phos} = \frac{A \times B}{C}$$

A = Concentration off curve
B = Final volume (L)
C = Mass of sample (Kg)

CALIBRATION CURVE FOR NITRATE

Sample	*Absorbance*
Calibration Blank	0.044
0.10 (mg/L)	0.050
0.20 (mg/L)	0.066
0.50 (mg/L)	0.122
1.00 (mg/L)	0.209
2.00 (mg/L)	0.363
4.00 (mg/L)	0.630

CALIBRATION CURVE FOR TOTAL & ORTHO PHOSPHATE

Sample	*Absorbance*
Calibration Blank	0.005
0.05 (mg/L)	0.075
0.10 (mg/L)	0.136
0.25 (mg/L)	0.310
0.50 (mg/L)	0.550

Correlation coefficient (R) = 0.9979
Y-intercept = 0.0206
Slope = 1.081

CALIBRATION CURVE FOR TOTAL & ORTHO PHOSPHATE

Sample	*Absorbance*
Calibration Blank	0.078
0.10 (mg/L)	0.120
0.20 (mg/L)	0.157
0.50 (mg/L)	0.251
1.00 (mg/L)	0.438
2.00 (mg/L)	0.766

Correlation coefficient (R) = 0.9997
Y-intercept = 0.0844
Slope = 0.3430

AMERICAN ANALYTICAL, INC.

Wet Chemistry Digestion Log Sheet

Batch #: 0918 Analyte: PHOSPHORUS Method: Aqueous Soli[illegible]

Sheet 1 of 1 Date: 9-18-92 Time: 9:00 Analyst: MZ

	Client	Sample I.D.	mL or g	Duplicate	Spike	mL Fin Vol	Comments
BLK		PBW 0918	50			50	
STD		LCSW 0918	50			50	0.50 mls of 25ppm Phos
STD							
1	ETLC	924245	50	50	50	50	0.50 mls of 25ppm Phos
2		924246	50			50	
3		924247	50			50	
4		924248	50			50	
5		924249	1.24			50	
6		924250	1.13			50	
7		924508	50			50	
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

AMERICAN ANALYTICAL, INC.
Wet Chemistry Digestion Log Sheet

Batch #: 0915 Analyte: TKN Method: Aqueous Solid

Sheet 1 of 1 Date: 9-15-92 Time: 9:00 Analyst: MZ

	Client	Sample I.D.	mL or g	Duplicate	Spike	mL Fin Vol	Comments
BLK		PBW 0915	125			250	
STD		LCSW 0915	125			250	0.25mls OF 1000 ppm NITROGEN
STD							
1	ETLC	924255	125	125		250	
2		924256	125		125	250	0.25 mls of 1000 ppm NITROGEN
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

AMERICAN ANALYTICAL, INC.
Wet Chemistry Digestion Log Sheet

Batch #: 0917 Analyte: TKN Method: Aqueous Soli[illegible]

Sheet 1 of 1 Date: 9-17-92 Time: 9:00 Analyst: MZ

	Client	Sample I.D.	mL or g	Duplicate	Spike	mL Fin Vol	Comments
BLK		PBW 0917	250			250	(REAGENT BLANK)
STD							
STD							
1	ETLC	924511	250			250	
2		924257	250			250	
3		924258	250			250	
4		924249	5.13			250	
5		924250	5.26			250	
6							
7							
8							
9							
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20							

American Analytical Inc.

A²I American Analytical Laboratories
7870 Broadway Merrillville, IN 46410
Tel: 219-769-8378
Fax: 219-769-1664

CHAIN OF CUSTODY RECORD

Number: 101613

Company: ETLC Contact: J. Camp

Facility Name: Upper Long Lake

Address: ~~1410 E St,~~ 204 2nd Street Phone: 324-9939
LaPorte, IN 46350

SAMPLE			MATRIX	PRESERVATIVE	ANALYSIS	LAB I.D.
Client I.D.	Date	Time	* * *	* * * * * *	* * * * * * * * * * * * * * * * *	* * * *
3 ft TPhos #1 OrthoP	8/30/92	12:00	H_2O	frozen	Total Phos + Orthophos	924245
3 ft TPhos #2 OrthoP	8/30/92	12:00	H_2O	frozen	Total Phos + Orthophos	924246
42 ft TPhos #1 OrthoP	8/30/92	11:00	H_2O	frozen	Total Phos + Orthophos	924247
42 ft TPhos #2 OrthoP	8/30/92	11:00	H_2O	frozen	Total Phos + Orthophos	924248
Bottom Sediment #1	8/30/92	14:00	Sediment	4°C	Total Phos + TKN	924249
Bottom Sediment #2	8/30/92	14:00	Sediment	4°C	Total Phos + TKN	924250

CHAIN OF CUSTODY CHRONICLE

Relinquished By:(print) Joe Camp Signature: [signature]
Date: 8/31/92 Time: 12:25

Received By:(print) ________ Signature: ________
Date: ________ Time: ________

Relinquished By:(print) ________ Signature: ________
Date: ________ Time: ________

Lab Received By: Carla L. Studer
Date: 8-31-92 Time: 12:25

COMMENTS: *Need all QA/QC w/ Report

American Analytical Inc.

7870 Broadway Merrillville, IN 46410
Tel: 219-769-8378
Fax: 219-769-1664

CHAIN OF CUSTODY RECORD

Number: 101612

Company: ETLC Contact: J. Camp

Facility Name: Upper Long Lake

Address: ~~1410 E St~~ 304 2nd Street Phone: 324-9939
LaPorte, IN 46350

SAMPLE			MATRIX	PRESERVATIVE	ANALYSIS	LAB I.D.
Client I.D.	Date	Time	* * *	* * * * * *	* * * * * * * * * * * * * * * * * *	* * * *
3 ft #1 NO_3	8/30/92	12:00	H_2O	1.0 mL H_2SO_4	Nitrate	924251
3 ft #2 NO_3	8/30/92	12:00	H_2O	1.0 mL H_2SO_4	Nitrate	924252
42 ft #1 NO_3	8/30/92	11:00	H_2O	1.0 mL H_2SO_4	Nitrate	924253
42 ft #2 NO_3	8/30/92	11:00	H_2O	1.0 mL H_2SO_4	Nitrate	924254
3 ft TKN #1 + NH_3	8/30/92	12:00	H_2O	0.4 mL H_2SO_4	TKN + NH_3	924255
3 ft TKN #2 + NH_3	8/30/92	12:00	H_2O	0.4 mL H_2SO_4	TKN + NH_3	924256
42 ft TKN #1 + NH_3	8/30/92	11:00	H_2O	0.4 mL H_2SO_4	TKN + NH_3	924257
42 ft TKN #2 + NH_3	8/30/92	11:00	H_2O	0.4 mL H_2SO_4	TKN + NH_3	924258

CHAIN OF CUSTODY CHRONICLE

Relinquished By:(print) Joe Camp Signature: [signature]
Date: 8/31/92 Time: 12:25

Received By:(print) ______ Signature: ______
Date: ______ Time: ______

Relinquished By:(print) ______ Signature: ______
Date: ______ Time: ______

Lab Received By: Carla L. Strater
Date: 8-31-92 Time: 12:25

COMMENTS: * Need all QA/QC w/ Report